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THE CERVEYRETTE BRIDGE AT BRIANCON.

TOWARD the middle of 1888 the engineer-in-chief of Briancon (Upper Alps), on the authority of the Minister of War, put in competition a project for the construction of a bridge over the torrent of Cerveyrette, designed to put forts Tetes and Bayard in direct communication. These forts stand opposite each other upon two summits, separated by a deep gorge which serves as a bed to the torrent. They had been connected up to then only by a very long road running along the banks of the ravine as far as to the valley of the Durance, where ends the torrent of Cerveyrette. The place selected for the establishment of the bridge presented the advantage of being situated at a point where the gorge is very narrow and the windings of the road are relatively close to each other. The result was a shortening by five or six kilometers of the distance to be traversed between the two forts. The gorge to be crossed had, at the level of the road, an opening of 75 meters and a depth of 85.

For economical reasons, the administration of war required a superstructure with a wooden flooring, leaving to the builders the selection of the system of girders to be adopted. Eight competitive projects were examined by the technical section of the engineer corps, which selected two presented by the same builders. By reason of the feeble dead weight of the work with respect to the supercharge—a condition resulting from the wooden roadbed—the first project included an upper flooring resting upon the back of two elastic crescent-shaped arches.

The variant presented in the second project indicated an upper flooring with a macadamized roadbed resting upon the back of two arches widened at the springings.

This last solution, which was more satisfactory as regards aspect, and preferable from the standpoint of stability, was applicable only by giving the dead weight considerable importance relatively to accidental supercharges—a condition realized by the use of a stone roadbed.

The relatively small difference in the cost of the two projects decided the engineers to adopt the proposed variant, and it was resolved: (1) That the bridge should be of the metallic arch system, of parabolic form, supporting a superstructure 4 meters in width, including a wagon road of 2·5 meters and two sidewalks of 0·75 meter each; (2) that the superstructure should be covered with a macadamized flooring; and (3) that the resistance of the work should satisfy all the conditions of the regulations.

Owing to the form of the gorge, which becomes narrower and narrower, an opening of 52·5 meters was allowed between the axes of the masonry abutments of the arches. It results that the latter have a theoretical chord of 51·45 meters, with a mean pitch of 11·5 meters—say a ratio of $\frac{1}{4{\cdot}5}$ of the pitch to the chord, this being very favorable to a saving in metal.

THE CERVEYRETTE BRIDGE.

The two arches are of the lattice type, and of parabolic form. Their height is 0·75 meter at the key, and 2 meters at the buttresses. They are inclined toward each other, with a spacing of 3·6 meters at the summit, and of 6 meters at the buttresses. Vertical latticed frames, spaced 3·75 meters apart, transmit the weight of the superstructure to the arches. Beyond the arches, these frames rest upon masonry pedestals. The two arches are firmly connected to the right of these uprights, by cross braces, and, besides, a cross bracing in the plane of the extrados assures the rigidity of the whole.

The lower and upper chords of the arch transmit the charge to the buttresses through the intermedium of cast iron shoes, and a system of keying with wedges permits of regulating the tightening and of thus assuring a proper distribution of the load.

The superstructure consists of two lattice girders, serving principally to tie the upper extremities of the uprights. The stone covering of the roadway is supported by 220 × 80 millimeter irons, weighing 15 kilogrammes per meter and placed side to side. Smaller irons support the cemented sidewalks.

The total weight of the metallic part of the work is 120 tons. The two cross-braced arches form 40 tons of this weight, say one-third of the total weight.

This work was finished during the autumn of 1889, and the keying of the arches was effected at a temperature of a little above zero. The depth of the ravine rendered the construction of the scaffolding designed to support the arches during the assembling of them particularly difficult. The asymmetrical form of the gorge permitted of cutting out of the rock an 8×6 meter platform to serve as a base for a tower 37 meters in height supporting at 25 meters a foot bridge 8 meters in width, as well as the upright frames to support the arch during the mounting.

In order to prevent the scaffolding as a whole from being overthrown by the action of the wind, the tower was anchored on each side by two cables attached to the rock. The different pieces of the scaffolding, as well as the sections of the metallic part, were moved to their respective places by a system of pulleys, man-

Fig.1.

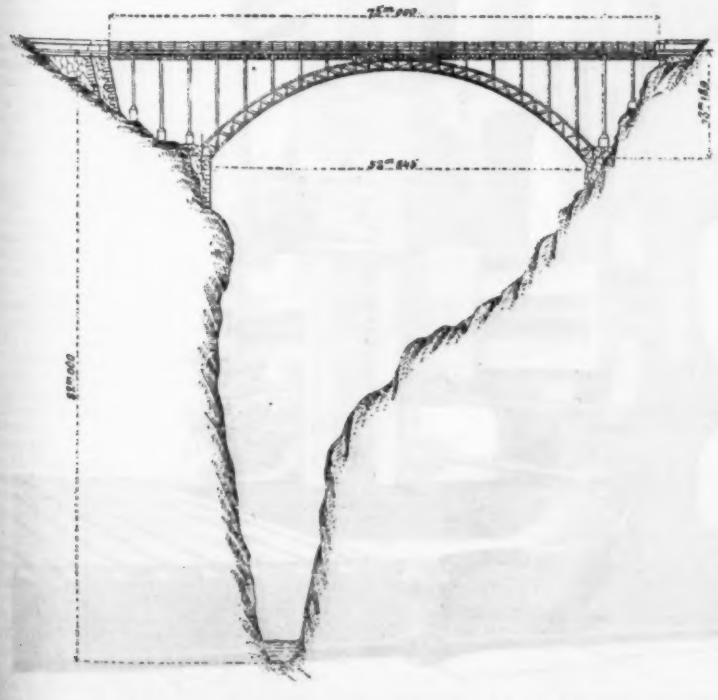


FIG. 1.—ELEVATION OF BRIDGE (Scale of $\frac{1}{500}$.)

Fig.2

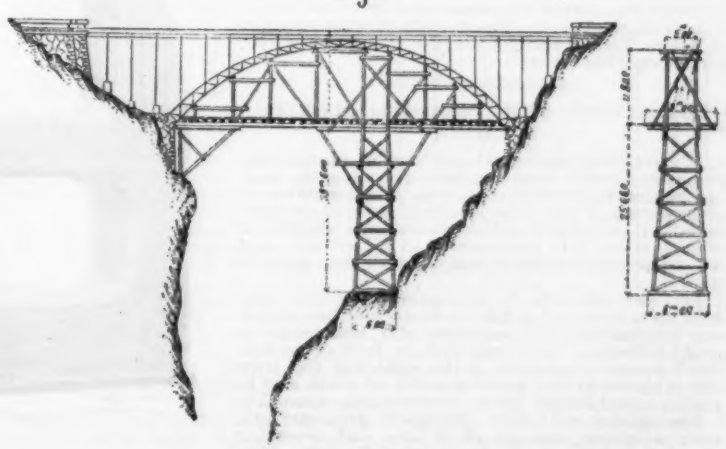
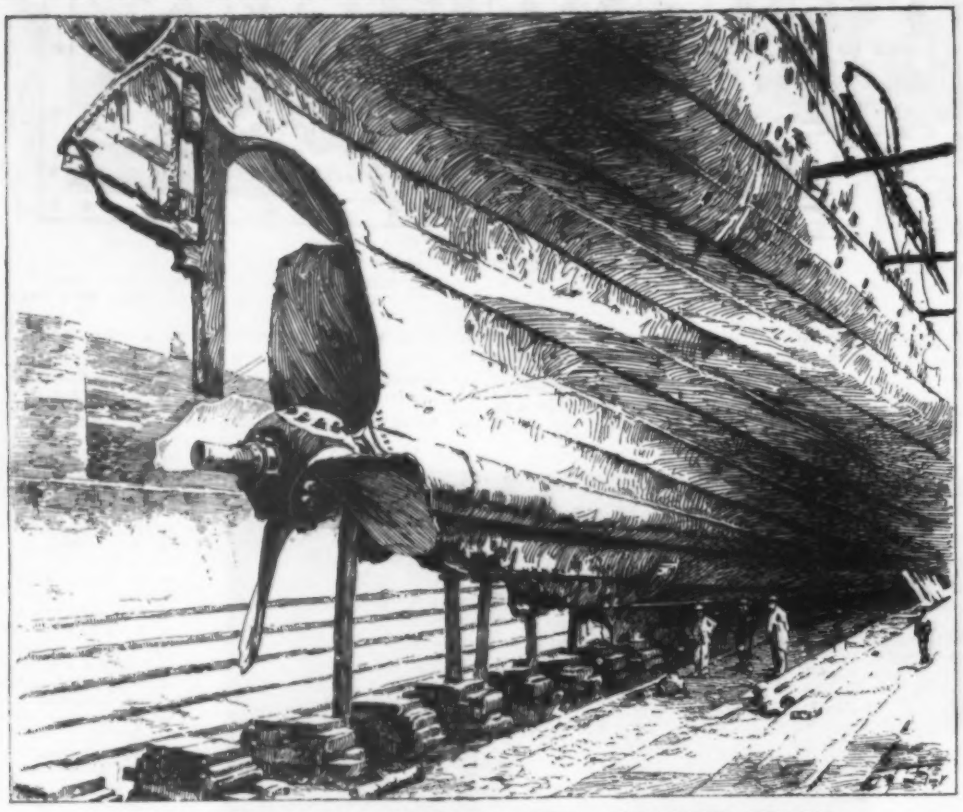


FIG. 2.—FOOT BRIDGE.



THE DAMAGED STERN OF THE STEAMER EIDER.

cuvered from the bank and suspended from a metallic cable stretched across the ravine. By reason of the peculiar circumstances, the preparation of the work had to be done at the shop before the construction of the service bridge, so that the exact measurements to be made *in situ* necessitated a series of operations in triangulation that were particularly difficult and dangerous.—*Le Genie Civil.*

THE FLOATING OF THE STEAMER EIDER.

Now that the North German Lloyd steamer Eider has been safely docked, it is possible to complete an interesting narrative of salvage work. The vessel was built of iron at the Fairfield Works, on the Clyde, and the fact that she was two months ashore and subjected to heavy seas with fresh winds from the south, which sometimes washed completely over the decks, is evidence of good workmanship. She went ashore at Atherfield Ledge, on the Isle of Wight, on January 31, and the Neptun Salvage Company's steamer Belos was sent to assist her, being followed by the Newa, of the Nordischer Bergungs-Verein, of Hamburg. The contract for the salvage of the steamer was on the "no cure, no pay" principle, and the two companies each sent another steamer. The work of removing the cargo by the four steamers was tedious, several divers being engaged. Five or six portable "Invincible" pumps, by Messrs. Gwynne, were put on board with donkey boilers. It was found that the pumps took off the water from the forepart, and it was believed that there was no important fracture there. Nor was there any leakage of consequence into the engine and boiler compartment; but aft, where the vessel had settled more decidedly in the blue slippery clay, there was a large opening in the ship's hull. The area of this hole was measured by the divers, and a steel plate made in the blacksmith's shop on board one of the salvage steamers to fit over the opening. This was bolted on and the edges packed to secure something approaching a water-tight joint. Pumping operations were then more effective, and on March 29, assisted by a high tide and a swelling sea, the vessel was successfully floated, and subsequently towed to dock at Southampton. The stern post was found to have been broken off just below the propeller, as was also the keel at a point about 25 ft. from the stern. The lower part of the rudder and rudder post are also cut away, although the propeller remains uninjured. These fractures, it is thought, are due to the Eider having come in contact with the hard cutting remains of some old wreck. This at all events is the theory of the marine manager of Messrs. Tozer, Hewitt & Co., the agents of the Neptun Salvage Company.

HORIZONTAL AND VERTICAL PLANING MACHINE.

THIS combined horizontal and vertical planing machine has recently been completed for one of the leading marine engineering concerns, and, according to *Engineering*, is one of the largest of its kind ever produced. It is entirely self-contained and capable of planing about 23 ft. horizontally, 18 ft. vertically, and 3 ft. transversely, while it weighs in all close upon 100 tons.

The base plate, on to which the object to be operated upon is secured, is 2 ft. in depth and has numerous longitudinal and transverse ribs underneath to avoid deflection. It extends 10 ft. in front of the tool, has T grooves planed out of the solid, and the front side is planed so that another width of plate may be readily added should future requirements demand it.

The uprights are hollow castings of great strength, each weighing upward of 10 tons and measuring about 12 ft. long at the base and 12 ft. high. They are securely attached to the base plate in front, and are stayed together at the back, while the horizontal beds, which are united to them by bolts disposed along the vertical faces, complete a rigid structure.

The upper and lower horizontal slide beds are each about 28 ft. long by 2 ft. wide on the face, and are strongly framed and bolted together. The lower bed has a very wide bearing surface for sustaining, without undue friction, the weight of the vertical slide-bed, and it is on this surface that the machine relies for the accuracy of its horizontal planing. In order to prevent deflection when the vertical bed is at work, there is provided at mid-length, between the uprights or thereabouts, a deep convex box girder cast on the underside of the horizontal bed. Intervening between the horizontal and vertical beds are two long sliding saddles, the lower one, upon which the vertical bed rests, being cellular in form and of strength sufficient to distribute its weight uniformly over the whole bearing surface, which amounts to upward of 6 square feet.

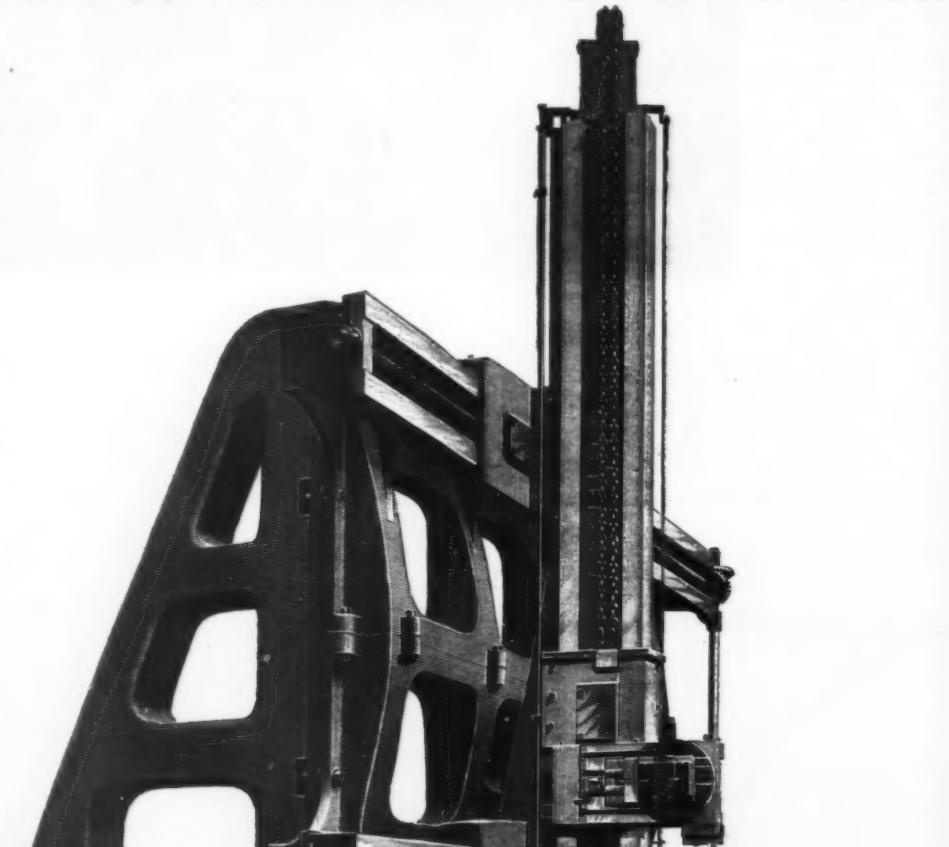
For planing horizontally, twin screws of steel rotated by bevel gearing and a steel vertical shaft driven from below are provided, while a single screw actuated by bevel gear and horizontal shaft effects the vertical planing or slotting. During the latter operation the twin screws, by a change of mechanism readily effected, impart the "feed traverse" and *vice versa*. The nuts belonging to the three screws are of hard gun metal and entirely encircle the screws, though in such a manner as not to interfere with their intermediate supports. For examination and repair the nuts may be readily removed and replaced, and that without any further trouble than is entailed by the withdrawal for a short distance of the vertical or horizontal screws as the case may be.

The vertical moving slide has upon it a self-acting transverse slide carrying relieving tool-holders for planing horizontally and vertically, and is counterbalanced by means of a weight suspended by chains within the vertical bed. The driving and reversing apparatus is self-contained and imparts to the tool a rate of "return" more than double that of "cutting." The length of stroke in either direction may be readily varied by means of adjustable stops while the machine is running, and the necessary adjustments are provided for varying the feed to the required extent.

The planing machine was constructed by Messrs. Hulse & Co., Ordsal Works, Manchester.

AN ACCIDENT IN AN ENGINE ROOM.

A SHORT time ago a serious accident occurred in the engine room of a New England mill, which was instructive enough to merit wider publicity than it has yet had. The engine is a 1,200 horse power Corliss, and it is supplied with steam by a 14 inch steam main, which enters the room about nine feet above the floor, passing horizontally along the wall for about eight feet,



COMBINED HORIZONTAL AND VERTICAL PLANING MACHINE.

and then turning downward and connecting with a pipe under the floor that supplies the engine from beneath. This main steam pipe is fed by smaller pipes running into it from each of the ten boilers in the boiler room, and it is provided with a main stop valve which is just outside and above the engine room door.

The engineer was just starting his engine up in the morning, when, without warning, the eight foot section of pipe running along the wall burst with a noise like a cannon, and steam at 100 pounds pressure rushed into the engine room with frightful velocity. The engineer was at the throttle valve between the two cylinders, and the powerful current of air and steam that rushed against him bore him helplessly across the engine room, to a door.

He struck the casing of the door, and succeeded in gaining sufficient footing to jump out instead of being blown out. The ground is twenty feet or more below the door sill, and the engineer says it seemed fully a minute before he landed. His right knee was badly sprained by the fall, but he hobbled around to the boiler room, and with the assistance of the two firemen tried to close the main stop valve over the engine room door. This was a difficult thing to do in the blinding blast of steam that issued from the engine room, and the effort proved fruitless. The valve failed to work, and the smaller stop valves on the individual boilers had to be closed before the draught of steam could be checked.

When the engine room could be entered it was found that the heat of the steam had unsealed the automatic sprinklers on the ceiling, and a perfect storm of water was pouring down on the engine The water supply was shut off, and the engine was examined and found to be uninjured, save for some rust that afterward formed on the wet metal.

The large cast iron main that burst was found split in halves, lengthwise, and fragments of it lay about the floor. An inspection of a large piece revealed the cause of the accident. On either side of this piece, where had been the parting of the mould, the casting was defective, and for perhaps four feet on both sides the metal was hollowed and blown, so that there was no union whatever, the casting being held together by a scale of iron hardly a sixteenth of an inch thick in places and hardly an eighth of an inch thick in most of its length. The upright length of pipe that ran down through the floor was blown over about six feet, so that the joints and valves under the floor were badly twisted and bent. Fragments of the bursted pipe struck and ruined the valve oiler on the cylinder, and a Locke damper regulator on the wall was also broken, the weights belonging to it being strewn all over the engine room floor. One weight, weighing about ten pounds, was driven across the room and embedded in the wall, making a hole eight inches deep and a foot in diameter.

The engineer was carried to his home after the accident, and it was found that his injuries, although serious and painful, were not fatal.

The moral of this accident is that cast iron ought not to be used for large steam mains carrying heavy pressures. Certainly, such pipes ought not to be used unless they have been thoroughly tested hydrostatically and with the hammer, and our opinion is that wrought iron pipes are always much safer and better.

While the failure of this pipe was due to its inherent weakness, accidents of a similar nature are often caused by the pipe being improperly supported. Supports provided for main steam pipes should receive the most careful attention, especially if the pipe is a long one. Steam pipes are exposed to great variations in temperature, and the consequent expansion and contraction is often very considerable, and needs to be properly provided for.—*The Locomotive.*

THE CAMERA AS AN ADJUNCT TO THE FACTORY.

By F. A. HETHERINGTON.

BUT little has been written concerning the utility of the camera in connection with the construction of machinery and engineering works of various kinds, yet here it may play a most important part, and I am led to believe, from my experience and that of others, that there exists in every machine-constructing and engineering establishment an often felt need for the photograph as a means of accurately recording the progress of construction, or the alterations from the design, which may be necessitated as work progresses. Progressive memoranda may thus be kept and used for reference in the future by the designers and draughtsmen. As it now is in most shops, the matter of the making of a photograph in the factory is generally considered a great bugaboo by all concerned.

The photographer is sent for, and he is expected to make a photograph of the newly finished machine that will come fully up to the ideas of the one who has to pay for it, and who is very apt to know what a good machine photograph is, from having seen the beautiful examples of the art that are carried by the missionaries who travel for the tool builders, and which are made by experienced professionals, who make this work a specialty. But what a disappointment when our prints are sent down to the factory, accompanied by the bill, generally not less then ten dollars.

Instead of the machine standing clear cut against a white background, it merely occupies a place among various other machines, belts, pulleys and what not. There is also a disagreeable sheen in innumerable small spots that gives to the principal object a cheap and disagreeable appearance.

Perhaps the photographer has made an attempt to stop out all surrounding objects with opaque. In such cases the chances are ten to one that all of the outlines are left ragged and often altered, and in the end the photographer is abused and all concerned are dissatisfied. The wood engraver is called upon to produce from the disagreeable photograph something "more like." Yet all this need not be, every factory may have its own photographer and the resulting pictures be fully up to expectations if the company will but invest fifty to sixty dollars in good apparatus, and the head designer, or one of his draughtsmen who has common horse sense, can be the photographer. I propose in the following paragraphs to inform those who may care to know of a few kinks connected with the making of machine photographs which will enable them, after some preliminary experience, to make excellent pictures.

In the matter of the first cost of the plant a few words may be said to advantage. One hundred dollars judiciously expended will obtain all of the necessaries and some of the luxuries necessary for the work. By luxuries I mean extra trays and graduates and a scale sufficiently large that a slight collision with the hand, in the dark room, will not send it jingling down behind some boxes. The latter is indeed a positive luxury.

The dark room may be built in any corner convenient to the water and sewer connections, and while about it do not try to economize either space or stability. True, a room three feet wide by four feet long will answer; but if it be five feet wide by seven feet long it will lead to much better negatives, as there will not be such an intense longing to get out before the plate has fully developed. Rules for constructing dark rooms may be found in any of the photographic text books and I shall pass that matter, merely dropping a warning that it is best not to hearken to those enthusiasts who paint glowing pictures of how you can construct a room by using some wrapping paper, a yard of black cloth and three nails. Have it as large as possible, have plenty of water, a good sink and some sort of a double-curtained door arrangement, so that you can easily leave the plate and get out when the boy raps on the outside and says, "There's a gentleman in the office wants to see you." To my notion the handiest camera for shop use is one that is made in Rochester and the most convenient size for machinery is 6½ × 8½ in. The best plate holder is that form known as the book holder. It is, I believe, an English invention, and although more expensive than the ordinary plate holder, it is of greater convenience.

On the section of a proper lens much depends. I have obtained good results with an 8 × 10 Darlot, used on 6½ × 8½ plate, and also with a Morrison wide angle lens. The Voigtlander euryscope is also excellent. In purchasing a lens it is well to select several and employ some photographer to make comparative exposures on 10 × 12 plates—with lenses intended for use on 6½ × 8½ plates—using for these exposures a very rapid shutter and working the lenses with the largest diaphragms, of similar openings for the lenses of similar focal length. These tests should be made by an experienced photographer who understands the laws governing lenses. On account of using the largest diaphragms it will be necessary to use very slow plates. I have found Carbutt's transparency plates serve the purpose very well.

After the negatives have been developed properly, prints may be made from each, and by comparison it is easy to select the lens best adapted for the work, selecting the one that gives the best general average of sharpness over the entire plate. It is not always the lens that cuts the sharpest in the center of the plate that averages best. The test above described is somewhat expensive if many lenses be tried, and if it be not advisable to use it, the word of a reputable manufacturer of lenses may be accepted in its stead. I refer to the manufacturer rather than the dealer, for the reason that in many cases the dealer knows but little more concerning a lens than its price, and is apt to assume that the lens of the highest price is the best one. For general shop use, where more than one lens cannot be had, it will be found that one having a focal length of about 8 in. will serve for the greatest range of work. Shop quarters being generally crowded, lenses of longer focal length can seldom be used, although, where their use is permissible, less distortion of perspective results.

For machine work the use of the vertical and side swing of the camera is necessary and it is useless to attempt such work with a camera having no swing-back. I shall not attempt to describe the use of the swing-back, for the matter is exhaustively treated in several standard works on photography, one of which is necessary to every beginner. For the use of the factory photographer Wilson's "Quarter Century of Photography" is recommended.

To move a piece of machinery of considerable weight from an ill-lighted part of a shop to a place where the light is well suited to photographic purposes is often a very troublesome and expensive operation, and it is generally the impracticability of accomplishing this purpose that causes the making of machinery photographs to be so unsatisfactory. It is a fact, however, that with a proper knowledge of the various resources of modern photography, very excellent pictures may be made of machinery as it stands in even the darkest corner of the shop; and in looking through my collection of pictures of machinery, I find very few photographs that were not made without moving the machine into a better light. To explain how this may be done, I will describe the method pursued in obtaining a picture of a heavy punching press. The press was a new machine, just finished, and was erected in the position in which it was to operate. Closely hedged in by other machines, it was but dimly lighted by the small dingy skylights far overhead and a small window at one side about twenty feet away. The effect of this skylight was such as to light one end of the machine while the other was in gloom. Under such circumstances it would have been impossible to have obtained anything like a correct general exposure, for while one and one-half minutes would have been about sufficient for the lighted end, the other end would need not less than ten minutes. The first step toward the work was to suspend from above a large twelve foot square white muslin sheet having heavy eyelets around its border one inch from the edge and spaced about thirty inches apart. Such a sheet is absolutely necessary for successful machinery photographs. After the sheet was hung in such position as to cut from the view all but the particular machine desired, the floor in immediate vicinity of the machine was entirely covered with white paper, such as may be obtained from any newspaper printer. In laying this paper care must be observed that it is laid shingling toward any wind or draught which may blow through an open door or window, otherwise the air will get under the sheets and blow them out of position. If properly laid, however, they will resist even a strong breeze.

It is very desirable, in fact essential, to good results that the machine should first receive at the hands of the painter a coat of priming paint having a mat surface when dry, with no gloss and of a gray color. The ordinary paint used about shops and which is known as iron filler is excellent for this purpose, and as it is customary to give all new machinery a first coating of this filler, it is only necessary to make the picture before the painter applies the final finishing coat. After the sheet is hung it is well to give prominence to any parts of the machine, such as bolt heads, handles or the lettering on name plates, by rubbing their surfaces with chalk applied by the finger and blowing away all particles that settle in the corners. This having been attended to, in the machine in question, the next step was to adjust the camera so that the image was suitable in size and properly focused upon ground glass of the camera. The side swing of the camera being set properly for the correct perspective, it was found that, owing to the dim light, it was necessary to use a candle flame for sharp focusing. The candle was held in such a position that its flame was close to the machine, almost against it and near its center. The camera was then adjusted until the flame appeared sharp upon the ground glass.

This much being now in readiness, the next step was to insert the smaller diaphragm to be used for the exposures and then to prepare a flash light of magnesium, for the purpose of lighting up the darker end of the object. In this case the light had to be in front and to one side of the camera, just out of the range of the picture. A large drawing board was used to screen the flash, so that its glare did not enter the lens. All being now in readiness, it was decided that one and one quarter minutes would be about the correct exposure for the lighted end of the machine, and while the exposure was being made the magnesium was flashed for the dark end. After the exposure the plate was taken to the dark room for development, leaving everything in readiness for another exposure in case the time was misjudged (for one can hardly fail to err sometimes in judging the intensity of light in various parts of a shop). Happily the time was rightly estimated in this case, and in the development the image of the white background came up very intense and black, while the image of the machine developed slowly and clear. This is the great desideratum in machine photography, to have background very intense, so that the image of the machine will stand against a white ground, clear and clean. After the negative was washed and dried, all of those surrounding portions not covered by the sheet image were painted out with Gihon's opaque, and it was ready for printing.

In photographing machines under such circumstances the flash light is invaluable, and being used in conjunction with daylight, its harsh effects are entirely destroyed. In my own practice I find it advisable to use guncotton in connection with the magnesium powder, as the results are more certain and the flash is sure to occur, which is not always the case if the magnesium does not ignite easily. Great care must be observed, however, in handling it. It often happens that certain parts of the understructure of a machine are in shadow, and where it is necessary to show such parts for mechanical reasons the magnesium cartridges with fuse attachment may be successfully employed, care being taken that the flash takes place behind some part of the structure that will shield it from the lens. By this means the whole of the under works may be well lighted. During my connection with the business of designing and constructing printing presses, and other like machinery, I used the camera with great profit, and have an invaluable collection of photographs of printing presses which form an almost complete pictorial record of the development of the printing machine from the early hand press down to the rotary perfecting press of to-day. Without my camera this would have been impossible. I have also many photographs showing alterations which have been made in machines, and fragments showing only that part which has been altered or improved, and these photographic memoranda have been so useful that I strongly urge the introduction of the camera into the designing department of every factory engaged in machine construction.

Before closing this article I will mention a method of opaquing the backgrounds in negatives of machinery which may or may not be original, but at any rate is a great improvement over other methods. The great difficulty in cutting out close to the outlines is well known by those who have tried it, for it is impossible to draw a true and straight line with a brush. If, however, the opaque be applied by means of a draftsman's ruling pen, it may be easily accomplished, and all of the straight outlines of the machine be ruled clear, for the opaque will not spread or run if of proper consistency. Having a broad outline thus ruled, it is an easy matter to fill the spaces with a brush in the usual manner.

When the white sheet is used as a background for the object to be photographed, it is well to have an assistant impart to it a waving motion during exposure.

This is done by seizing one corner of the sheet and gently shaking it. By this means all folds or creases which may be in the sheet will not appear in the negative, which will have an even opaque background.

THE AUTOMATIC STILL IN RUM AND ALCOHOL MANUFACTURE.

By GEORGE STADE.

As the molasses question has become a very serious one at present, it is very important for sugar planters to discuss the possible solutions of this topic in a thorough manner. There is no doubt that in most cases the manufacture of rum or alcohol from molasses is one of the simplest and, for many plantations, the only way open to them for avoiding large loss from the ruling low prices of this refuse product of the sugar industry.

In the case of erecting new rum or alcohol distilleries it is evident that the most rational way of establishing a new modern industry in countries like Louisiana, which have thus far but little experience in the matter, is to go in at once for the central system. It is to be regretted that the various efforts made thus far in Louisiana in the matter of molasses distillation have only been crowned with partial success. It is clear that there is plenty of room for many large distilling establishments. Meanwhile other countries have taken up the matter with admirable energy and with the necessary capital. Last year the British Guiana Distillery Company was organized, with a working capital of $50,000. This company has perfected the organ-

ization of the largest molasses distillery in the whole world, and of a magnitude hitherto never contemplated. This establishment, which really deserves the name of usine, or central factory, is being built by Messrs. Stade & Co., of Charlottenburg 2, Germany, for the well known Cardenas refinery, Cuba. When in full operation it will have a minimum capacity of 11,000 American gallons of molasses per twenty-four hours, or say about 70,000 American gallons of *wash* in the same time. The plant is built in accordance with the most recent experience and in the most modern fashion. There are twenty fermenting tubs of 14,000 gallons capacity each, and with a refining attachment for making the necessary wash or mash for distillation. The rum is guaranteed to be of choice quality and of very high strength, say 97 per cent. by volume alcohol, or 194° American proof, which exceeds 67° English proof or 42° Cartier.

The still that distills this wash is one of the largest ever built. It is constructed according to the newest patents of that ingenious specialist in distilling apparatus, Mr. Robert Ilges, of Cologne on the Rhine. Referring to the article *Distillation in the West Indies*, which appeared in the *Louisiana Planter* of March 5, 1892, it may be the place here to answer the questions of Mr. J. P. Edwards, of Barbados. In fact, the problem of extracting refined or neutral spirits from the wash, which has hitherto been thought to present insuperable difficulties, has here reached its solution.

All the second runnings are speedily discharged, while the remaining portions of the wash are subjected to boiling for a very short time only; for *the wash leaves the apparatus five minutes after entering it*, and *the singlings, as well as the acids, of slow evaporation, ten minutes after the condensation*, so that *no time is afforded for chemical decomposition*, apart from other impediments to such decomposition. The formation of aldehydes is also rendered impossible, as, in consequence of the uniform motion, the refined spirit vapors are condensed in the cooler in an atmosphere of carbonic acid, and thus do not come in contact with atmospheric air.

While the automatic still for refined spirit does away with a number of processes hitherto indispensable in the manufacture of spirits, namely, the cleansing processes, it not only replaces, in the simplest possible manner, the distilling apparatus, the battery of coal filters and the rectifying apparatus, but also offers further great advantages. It furnishes none of the worthless by-products of rectification, nor any spirit of such poor quality as the lowest class of the refined products of common rectification; it turns out exclusively a valuable and marketable spirit of absolute purity, which is at least equal to the choice products of the common refining process. The automatic still for refined spirit further causes no loss of alcohol, while in filtering and rectifying full 2½ per cent. of the alcohol is lost. The only by-product of the automatic still for refined spirit, namely, fusel oil, has a good market value, and may, moreover, be used with absolute safety for illuminating purposes.

Many more advantages of the automatic still for refined spirit might be enumerated; for, apart from the success of its principal application, it excels in every other particular every description of wash distilling apparatus. Its manipulation is most simple, as the working is automatic. The working of the apparatus can at any time be checked by the owner or distiller, by a glance at the contrivances which are attached to the apparatus for this purpose, and which furnish constant and precise indications as to the working of each part. *Obstructions in the stream of wash are absolutely impossible*, seeing that all the surfaces of the wash column introduced by Ilges in 1873 incline downward, and the consistent parts of the wash, instead of adhering thereto, descend with increased speed, and quickly leave the apparatus at the lowest point. The cleansing of all the cooling surfaces, as already mentioned, is greatly facilitated. Experience has proved that smaller quantities of steam and water are required than for raw spirit stills. The durability of the Ilges apparatus has long been established, as many of these have been in use for sixteen or seventeen years; the automatic still for refined spirit, every part of which is constructed of the most suitable material (cast iron or brass), will outlast several generations of copper stills without requiring a single repair.

The automatic still for refined spirit has been acknowledged by all practical and theoretical men who have become acquainted with it to be one of the most important developments in the field of spirit manufacture. The Berlin "Association of Spirit Manufacturers in Germany," after having thoroughly examined the apparatus, has spoken in terms of the highest praise, both of the advantages of its construction and of the excellence of its product. Their report concludes with the statement that "Mr. Ilges' latest invention must be considered as an improvement of the greatest importance for the spirit industry."

A second report of the same association, delivered verbally by Dr. Hayduck at a general meeting held in Berlin on February 21, 1891, concludes as follows:

"If the apparatus, when once set in motion, works perfectly automatically, with every degree of safety, and really requires no supervision, then it must be confessed that we have before us a most remarkable construction, affording a solution to a problem hitherto unsolved; and it would be unfair not to acknowledge that Mr. Ilges, by this important invention, has earned the thanks of the entire spirit-manufacturing community of the world."

As to the quality of the spirit produced by the automatic still, a well-known authority, Professor Dr. A. Stutzer, expresses himself as follows at the close of his report:

"In view of the fact that neither first runnings, fusel oils nor other component parts of the second runnings can be detected in your spirit, even when subjected to the most severe tests, and that the results as to smell are perfectly satisfactory, I have no hesitation in expressing my most favorable opinion as to the quality of your spirit, and am further persuaded that your process is destined to effect a complete revolution in the spirit industry."

Last, but not least, the author of the *Manual of Spirit Manufacture*, Professor Doctor Max Maercker, of Halle, so widely known, says, in his latest, fifth, edition of this admirable work, page 602:

"The Ilges apparatus is a most ingenious invention, and has an excellent reputation all over the world. . . . The apparatus is of most modern construction, and gives an extremely pure spirit, and works with absolute safety, regularity, and automatically."

The Ilges apparatus is now used in nearly all countries of the Old and New World. For instance, the house of Ernesto Tornquiste & Co., of Buenos Ayres, Argentine Republic, is working this crop with two new apparatus consuming about 250,000 liters of wash in their sugar factories at Tucuman.

Of course, there is a great difference between rum or molasses distilleries, as well as between sugar factories making old style muscovado sugar with windmills and open kettles and those modern factories extracting their juice with multiple crushing or diffusion apparatus and multiple effect and vacuum pan evaporation. Small places, which do not desire modern improvements, will very likely not want automatic refining apparatus, while, on the other hand, distilleries which claim to keep step with the science of chemistry, bacteriology, and ingenious invention, cannot do without them.

The question of Mr. J. P. Edwards with regard to the terms cannot be answered in general terms. It must be kept in mind that the alcohol originates in the fermenting house and not in the still, just as the sugar in the cane develops in the field, and not in the boiling house. All the still can do is to prevent any possible loss of spirits. If the fermenting room is kept in good order and the molasses is not spoiled, *i. e.*, burned or otherwise injured, there is no trouble to secure 80 per cent. of the theoretical yield, presuming that the fermentation process is managed with ability and by proper and rational means. A sample of the spirits made in the Ilges apparatus can be seen at the office of the *Louisiana Planter* and will be found to be of choice quality and absolutely free from fusel oil. —*La. Planter.*

MANUFACTURE OF POWDERS AND NITRATED EXPLOSIVES.*

Utilization of the Sub-products of the Manufacture of Nitric Acid.—We have already mentioned the necessity of employing, for the preparation of nitrated explosives, pure and concentrated acids, with which the nitration is surer and more rapid. It is even probable that if the monohydrated acids were chemically pure, there might be obtained a rendering very close to that of the theoretic, and, besides, that the nitration might be considerably attenuated.

In a preceding article, we have given the method of obtaining nearly pure sulphuric acid cheaply. We may likewise prepare nitric acid concentrated to 95 per cent. of monohydrate and containing no more than from 2 to 3 per cent. of nitrous vapors and chlorine.

The manufacture of nitric acid is simple. It is based upon the decomposition of nitrate of soda by sulphuric acid, according to the theoretical formula:

$$NaAzO^3 + H^2SO^4 = AzO^3H + NaHSO^4.$$

The mixture of nitrate and acid is heated in a cast iron retort, and the nitric vapors condense in earthen cylinders or pipes, while the other gases are dissipated in a coke tower. Theoretically, one molecule of nitrate and one of sulphuric acid give two molecules of nitric acid and one molecule of sulphate of soda. But it is necessary to employ an excess of sulphuric acid, because one part of the latter combines with the sulphate to form a bisulphate, which retains about 25 per cent. of its weight of sulphuric acid.

With his arrangement of condensers in the form of earthen pipes 2·5 meters in height, Mr. Guttmann succeeds in obtaining an acid that contains from 94 to 95 per cent. of monohydrate, and the specific gravity of which is from 1·5 to 1·51, say 48° to 49° B.

There is no advantage gained in producing a more concentrated acid, especially when it is a question of nitrating cellulose, since, above 95 per cent., the acid attacks the cotton, as Mr. Vieille has ascertained.

The Guttmann apparatus generally comprises four retorts, each of which contains 620 kilogrammes of well dried nitrate and 170 or 180 kilogrammes of sulphuric acid. An operation that lasts from 12 to 14 hours gives, for a furnace of four retorts, about 1,500 kilogrammes of nitric acid and 2·574 of bisulphate of soda, which retains from 24 to 27 per cent., say about 640 kilogrammes of sulphuric acid.

Up to the present this sub-product had not been utilized, and it was got rid of in any way possible, but not without difficulty. In certain cases it accumulated in piles in the vicinity of the works, but in the long run infiltrations of acid into the earth and water occurred, which were frequent causes of damage and complaints.

At the Spanish dynamite works of Galdacano it was utilized for the manufacture of hydrochloric acid and neutral sulphate by the Leblanc process.

Upon the whole, the bisulphate has always been considered as a troublesome subproduct without value. The utilization of it, as recently proposed by Mr. Barbier, by a simple and cheap method, constitutes an important progress in the manufacture of powders and explosives.

Mr. Barbier's process comprises the two following operations: 1, the bisulphate is decomposed into neutral sulphate and sulphuric acid by submitting its solution to an artificial cold of from —10° to —11° C.; 2, after collecting the sulphate formed, the acid waters are treated in order to extract therefrom the sulphuric acid concentrated to 66° B.

This reaction produced by cold is a consequence of that principle of thermo-chemistry that Laplace and Lavoisier established at the end of the last century, viz., *the heat absorbed or disengaged by decomposition is equal to the heat disengaged or absorbed by combinations.* It is this that explains that it is possible in certain cases to bring about the decomposition of a combination formed by the action of heat by submitting it to the inverse action of cold.

In the case that occupies us, the bisulphate formed at a high temperature is decomposed by cold in the following way: We begin by dissolving it in cold water, so as to obtain a liquor marking 36° B. It is a solution of 100 kilogrammes of bisulphate per 160 kilogrammes of water. Then, through an ice machine or any other means, we reduce the temperature to —10° C. Upon agitating the liquid, the greater part of the bisulphate becomes decomposed, and we obtain a snow-like deposit of sulphate of soda. It is a sulphate hydrated to 10 equivalents of water:

$$NaHSO^4,10H^2O,$$

which crystallizes in prisms and presents the following composition:

Water	55·76
Anhydrous sulphate	44·24
	100·00

100 kilogrammes of bisulphate (H^2SO^4,$NaSO^4$) give 160 kilogrammes of hydrated sulphate ($NaHSO^4$,10 H_2O).

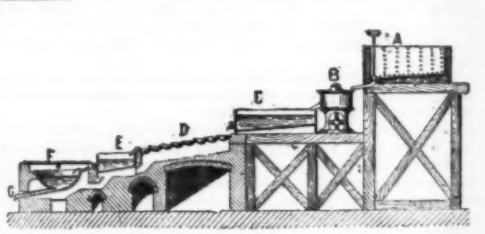
The crystals are separated from the mother water by a hydro-extractor, and the last traces of water are removed from them by washing them with a small quantity of water and passing them a second time through the hydro-extractor. These operations must be performed at a low temperature, for above +15° C. the sulphate, crystallized in prisms, tends to become converted into amorphous sulphate, which is a mixture of amorphous anhydrous sulphate and amorphous hydrated sulphate.

The crystallized sulphate thus obtained is pure. It meets with a ready and lucrative sale. It is used in dye works and veterinary pharmacies, which consume quite large quantities of it.

If need be, we can convert it into anhydrous sulphate for glass works. To this effect, it suffices to heat it very slowly, toward 40° C., in a revolving or oscillating vessel. After the extraction of the salt, there remain two deposits of mother waters. The first, which mark from 27° to 30° B., consist of a very acid solution of bisulphate. The second, which are but slightly acid, are used in a subsequent operation for dissolving a new charge of bisulphate.

In order to recuperate the sulphuric acid of the rich mother waters, the latter are passed through a double row of porcelain or lead capsules, arranged one above another and heated in the open air. After a proper degree of concentration has been obtained, they are drawn off into a cast iron boiler heated by a direct fire. A concentrated water, and then a concentrated acid is obtained by distillation, and there remains a certain quantity of bisulphate in a pasty state, which is made to re-enter the cycle of the preceding operation by adding it to the bisulphate to be treated.

The accompanying figure gives a section of an arrangement that permits of operating in a continuous manner.



TREATMENT OF BISULPHATE OF SODA.

A, cooling reservoir; B, turbine; C E, reservoirs; D, furnace for heating the acids; F, boiler; G, pipe for outflow of the bisulphate.

The solution of bisulphate is decomposed in the cold reservoir, A, and then the mixture of sulphate and mother waters is turbined in a series of centrifugal hydro-extractors, B. The rich mother waters are sent to the reservoir, C, whence they flow through two siphons into the porcelain capsule furnace, D, then into the reservoir, E, and finally into the cast iron boiler, F. The waste heat of the fireplace under this boiler serves to heat in succession the small reservoir, E, and the capsules.

The pasty bisulphate which remains in the boiler after the distillation of the acids is collected in the pipe, G.

One hundred kilogrammes of bisulphate submitted to these various operations give:

131	kilogrammes of	crystallized sulphate.
34	"	" sulphuric acid at 66° B.
10	"	" " " " 18° or 20° B.

If 5,000 kilogrammes are treated per day, say 1,500 tons per year, the following results are obtained:

	Francs.
1,950 tons of crystallized sulphate, at 40 francs per ton	78,000
360 tons of sulphuric acid, at 66° B., at 80 francs	28,800
150 tons of weak sulphuric acid	.....
	106,800

The expenses include:

	Francs.
Fuel, at the rate of 40 kilogrammes per 100 kilogrammes of bisulphate, say 700 tons at 30 francs per ton	21,000
Manual labor, 360 days, at 20 francs per day	7,200
Maintenance and repairs	3,000
General expenses, interest, etc.	15,000
	46,200

The profit, therefore, is 60,200 francs. This will be sensibly increased if we take into account the bisulphates and the weak acids that remain at the end of the treatment and that are made to re-enter the cycle of the successive operations.

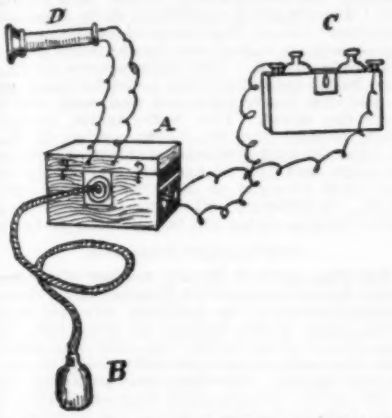
This important result demonstrates the great advantage that results from the treatment of a subproduct which, up to the present, it has never been possible to utilize, and which certain large works cannot get rid of except by the outlay of money.—*Le Genie Civil.*

* Continued from SUPPLEMENT, No. 839, p. 13406.

THE TORPEDO DETECTOR.

AN electrical appliance known as the McEvoy's torpedo detector is used in searching for torpedoes or mines in harbors and channels. The apparatus is shown in the figure, and when in use is carried in a boat or launch. The metal sinkers, to which the small cable is attached, are dragged along the bottom of a harbor or channel where the presence of torpedoes is suspected. When the telephone is placed at the ear, no sound is audible until the sinker reaches the vicinity of some metallic body, such as a torpedo, then a buzzing noise is heard, which becomes gradually louder as the torpedo is approached, and loudest when it is touched.

Electricity is employed on some of the English ships, and is just being adopted on our own naval vessels, to



A, induction coils; B, sinker; C, batteries; D, telephone.

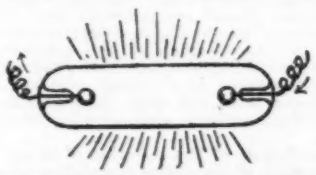
McEVOY'S TORPEDO DETECTOR.

render the sights of the guns visible when firing at night. Two wires from an induction coil lead to the rear sight of the gun, where they are slightly separated just at the apex of the sight, so that the electric sparks passing between them serve to mark the position of the pointer.

NIKOLA TESLA AND HIS BUSINESS.

NIKOLA TESLA'S production of an aurora, in the lecture rooms of New York, London, and Paris, comes as a sequel to experiments that reach back all the way to the famous kite-flying of Franklin. How readily electricity glides into light everybody knows who has walked along a fleecy carpet and applied his finger tip to a bell wire or a water pipe. Indeed, so readily do sparks stream from electrical machinery that such machinery has to be excluded from mines and other places where a spark might cause an explosion. To bring the electric spark to magnitude and continuity has been a task which these many years has occupied an army of inventors. In their progressive steps these inventors have been greatly indebted to the induction coil, especially as improved by Ruhmkorff. His apparatus consists, essentially, of a coil of ordinary wire encircling a second coil formed of extremely fine wire. When a momentary current from a battery or a dynamo is sent through the first coil it induces in the second a current so highly intensified as to flash forth as lightning. In an apparatus of large dimensions this discharge can be thirty inches in length. Developed in form, the induction coil has been indispensable in Tesla's experiments. His work has distinctly diverged from the line of investigation which has given us light as an incident of the intense heat of carbon threads and pencils. He has sought to obtain light directly from electricity, avoiding costly and useless partnership with heat. On this particular track Dr. H. Geissler, of Bonn, labored long ago. In the tubes known by his name he produced a luminous glow of great beauty, sending through highly rarefied gases the pulsations from an induction coil.

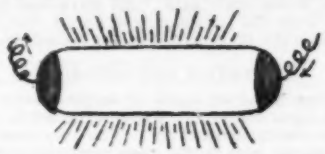
With a better air pump and a more powerful coil, William Crookes, of London, the discoverer of the chemical element thallium and inventor of the radiometer, took up Geissler's experiments and extended



THE FIRST STEP—GEISSLER TUBE, WITH ELECTRODES INSIDE THE GLASS.

them by a very significant step. He discovered that the electrodes or current carriers were fully as effective when attached to the outside of the tube as when brought within it.

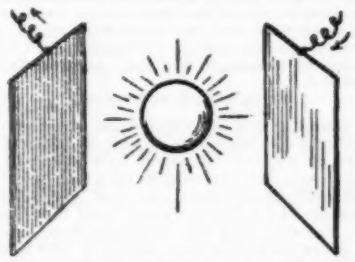
It was at this interesting and suggestive stage of development that Tesla began to solve the problem of how electricity might best be changed into light. He had been engaged in perfecting a generator of alternating currents, a machine of novel and excellent pattern. It occurred to him that these currents gave him a means of experimenting on lines wholly new; for an alternating current differs from a continuous one as puffs of air, now from north, now from south, differ from a constant breeze in either direction. What might he not do were he able to change electricity from a stream to vibrations approaching in period those of light? In the apparatus he used in his lecture at Columbia College last year, Tesla departed very far from the ordinary alternator with but a dozen poles in its circle. On the rim of his rotating disk he had no less than 384 poles, which gave 9,600 alternations per second instead of 300, a customary number. In his later work Tesla adopts the current as delivered by the common alternator used in electric lighting. For increasing the frequency of its reversals he employs a condenser and converter such as he had at Columbia College, but now much developed in form. This contrivance consists of a transformer, of the type familiar to consumers of electric light, with a second transformer having in its circuit a magnetic spark interrupter, from which is obtained discharges in all respects similar to those of the



THE SECOND STEP—CROOKES' 1891 TUBE, WITH ELECTRODES ON THE EXTERIOR OF THE GLASS.

largest induction coil—discharges of high frequency. Connecting this circuit in turn with a condenser, a series of Leyden jars, a surging effect is produced. The currents are raised from vibrations of 25,000 or so per second to between one and two millions. At the same time their pressure is heightened in a corresponding degree. Thus armed with powers wholly new in electrical experiment, Tesla proceeded to win new victories. Whereas Crookes found it enough that his electrodes merely touched the outside of the tube which he was to set aglow, Tesla produces the same luminosity by entirely detaching his electrodes from the tube and retiring them to a distance of several feet.

In the intervening space, with no wires or connections of any kind, he places glass tubes, or globes, which shine as if auroral beams from the northern sky were entrapped in them. The light here is due so to speak to molecular bombardment, to the particles of imprisoned gas striking one another with a velocity so tremendous as to glow visibly. We have a familiar illustration of the same kind of fact when a nail is violently and repeatedly struck by a hammer on an anvil until it reaches glowing heat. But resuming the path of his main purpose, the getting light unaccompanied by heat, Tesla has arrived at results more remarkable still. As fast as he was able to increase the frequency of electric alternations he tried a variety of experiments. Among these was the admitting of more and more air into the exhausted tubes placed in the

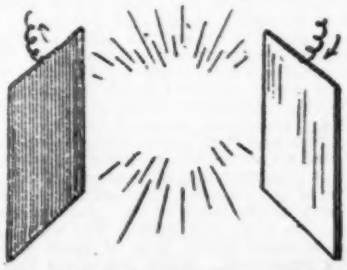


THE THIRD STEP—TESLA 1892 EFFECT, WITH DISTANT EXTERIOR ELECTRODES.

excited electric field. He found to his great delight that the luminous effect persisted, and this to the point when a tube was exhausted in no degree whatever. He was now led to the culmination of his work—the dispensing with tubes altogether, the production of light by agitations of the light-bearing ether so rapid as to provoke vision. In his latest experiments Tesla suspends from the walls of a room two metallic plates, attaches them to the poles of his condenser, and in the intervening space, without tubes, globes, or other objects, creates a soft and diffused glow. The light is fainter, however, than that which shines in a tube or globe brought into the electrified space.

Without any mechanism whatever in view, and from precisely such an alternating current as that fed to arc and incandescent lamps, an effect without example in the art of lighting is made available for the drawing room, the theater, and the picture gallery. In a scheme devised by Mr. John Van Vleck, an electrical engineer of New York, the ordinary current as delivered to a consumer can serve to actuate a motor, can be turned into lamps, or applied to producing the Tesla effect.

Tesla is busily engaged in perfecting his results by successive improvements in the appliances for their production. As his light seems to be unallied with heat, and its user is free from the cost and care of lamps, its further development is awaited with the keenest interest. Yet, even in its present state, the Tesla apparatus must rank with Franklin's kite, which



TESLA'S LATEST EFFECT—A LUMINOUS CLOUD BETWEEN TWO ELECTRODES.

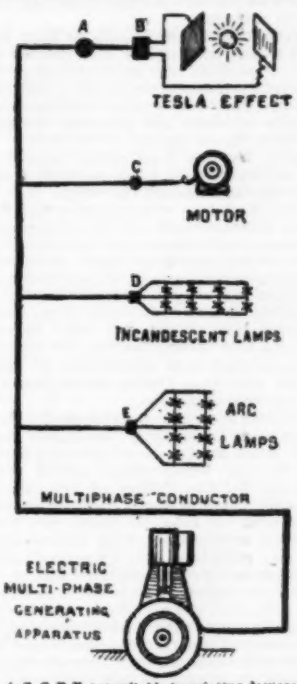
showed electricity and lightning to be one; with Bell's disks, which either electricity or light can arouse to speech; and with Hertz's resonator, which proves to the eye what so long was but an unfulfilled anticipation, that, after all, light is only a particular effect of electro-magnetism.

Indeed, Tesla's experiments make clear that every common flame is but a brilliant manifestation of electro-magnetic energy. Attached to a pole of his condenser, a thread of cotton streams forth with a flame like that of Moses' bush, which burned but was not consumed. From the two terminals of his apparatus are emitted brush-like electric discharges that not only resemble, but are veritable flames. Let the current mount still higher in its pressure, beating still faster, and to touch as well as to sight the identity would instantly become evident. By varying the substances which he exposes to his currents, Tesla produces exquisite effects in color.

Phosphorus with sulphate of zinc gives, for example, a greenish glow of great beauty. With yttrium, artificial diamond, lime, and various metals, other hues appear, and, what is of much promise, the degree of luminosity is increased. In all cases, the light is brightened, too, when above it is placed an ordinary metallic shade. In this path of experiment may lie the object which Tesla has constantly in view, the production of a light brilliant enough to be compared with that of the incandescent bulb. In lines less directly leading to practical utilities his demonstrations abound with suggestiveness. He has shown, for example, how two beautiful phenomena shade into each other, when the phosphorescent gleam of a ruby is brought to incandescence through intermediate stages of excitation. And sending electric impulses through glass stained to canary hue with oxide of uranium, and through solutions of sulphate of quinine he produces fluorescence of a new brilliancy.

AN ELECTRIC COLUMBUS.

In bringing electrical vibrations nearer to the frequency of light than any other inventor has done, Tesla is the Columbus of a new continent for inventive activity. The undulations we call light are stopped by fog, because they occur at a certain rate. Let vibrations of a rate such as Tesla can produce be projected into space, and the possibility dawns for giving ships a new security at sea. An electric station on shore or reef may warn the mariner by sending forth



A, B, C, D, E, are suitable translating devices.

THE VAN VLECK SCHEME FOR SUPPLYING THE TESLA EFFECT, ARC AND INCANDESCENT LAMPS, AND MOTORS, FROM THE SAME SYSTEM.

electric impulses to be received and registered on suitable disks aboard his vessel. And in ocean service of another kind, in quickening the speed of signaling through the cables, there is a promise that Tesla's apparatus can be usefully enlisted. It takes about one-third of a second for a signal to cross the Atlantic, and any device which will shorten this period must proportionally increase the carrying capacity of the submarine wire. That a wide margin for improvement exists here has been demonstrated in the shortening of time in transmission effected since cables were first laid. It is generally supposed that, as used in telegraphy, the electric current has an exceedingly high velocity from which it never varies. Not so. The length and quality of a conductor, the character of its insulation, and the peculiar form of the current, are elements which decide the rate of propagation.

In bridging part of the wide interval between the comparatively slow waves which excite the sensation of sound and the vastly swifter ones which awaken vision, Tesla opens the door to an illimitable realm of experiment. To waves of a new order the old rules of arrest and transmission will not apply. Alexander Graham Bell, in his experiments with the photophone, found that an invisible beam of light easily passed through a sheet of hard rubber. Tesla in the same way finds that insulation is a relative term. Substances that keep ordinary currents strictly to their path are easily pierced by the throbs which he enkindles. Oil, which closes over an electric wound, has therefore to replace cotton, silk, and rubber. It would seem, in truth, as if the electrician will soon be able to choose the special vibration suited to traverse any medium whatever, gaseous, liquid, or solid; that he will encounter no obstacle which he cannot render as it were transparent.

WHO NIKOLA TESLA IS.

Who is this man who has done so much and initiated so much more, before whom the Nestors of European

science sit entranced as he brings before them marvel after marvel? Whence does he come? What country gave him birth only to surrender him to America?

On the southern confines of the empire of Austria-Hungary, Croatia comes to the Adriatic Sea. Here is a land of mixed races, of a history so troubled that its language holds a hundred words for knife, and but one for mercy. Here in the hamlet of Smiljan, Nikola Tesla was born thirty-five years ago. At Carlstadt, in Croatia, and at the polytechnic school in Gratz, Austria, he received his education. As a student of engineering the subject of electricity strongly attracted him, and he devoted his spare time to electrical experiment.

On graduating in 1881 he entered the telegraph service at Buda-Pesth, taking up the electric light and the construction of dynamo machines as his special work. About five years ago he came to the United States. During part of this time he was in the employ of the Westinghouse Co., where he earned the highest esteem as an electrician and as a man. Latterly he has pursued an independent course of experiment, with results briefly touched upon in this article.

In person Tesla might pass for an Italian. He has an Italian sensitiveness of temperament, as well as an Italian excitability. His command of English is capital, and as he unfolds his results to an audience with exquisite dexterity, his enthusiasm is contagious. With inborn resources of the rarest, with excellent education and practical training, with the opportunities of the world focused around him, what of achievement may not the future hold for Nikola Tesla?—*George Iles, in N. Y. Sun.*

THE EVOLUTION OF COMMERCE.*

ANNUAL ADDRESS BY THE PRESIDENT.

By GARDINER G. HUBBARD.

FOR over three thousand years the great highway for commerce has been from India by the Persian Gulf and the Euphrates or by the Red Sea to the Mediterranean, and thence through the Mediterranean by Gibraltar to western and northern Europe, and in our day thence to America.

Along this route cities and nations have sprung up, increased in wealth and power, and passed away, giving place to other cities and nations further westward. These nations have been great carriers and distributors of minerals and goods, as well as capitalists and bankers, or carriers, bankers and manufacturers; in either case controlling the commerce of the world. This control has never for any long period been held by the same race, but has passed from one nation to another, always from the east toward the west.

The earliest highway of commerce was from India through the Persian Gulf, up the Euphrates to the Mediterranean; and carpets and precious stones were then as now carried over this route. Explorations and surveys for a railroad have been recently made along this "our future highway to India." Caravans brought spices from Arabia and rich stuffs from Babylon and Nineveh to the shore of the Red Sea. Solomon made a navy of ships and Hiram sent in the navy his "servants, shipmen that had knowledge of the sea, and they brought gold from Ophir, great plenty of almug trees, and precious stones."

Tyre and Sidon founded colonies on the shores of the Mediterranean, enslaving the Spaniards and compelling them to work the mines of gold and silver already opened in Spain. Their ships sailed through the Mediterranean, by the Pillars of Hercules, into the Atlantic Ocean, turning northward to England for tin and copper and on into the Baltic Sea for furs and amber; turning southward along the western coast of Africa, passing certainly two thousand miles to the equator and probably rounding the Cape of Good Hope into the Indian Ocean. Products from the west were brought in ships to Tyre and Sidon and exchanged for the goods of the east, their merchants making profits on each transaction both as merchants and as carriers. Tyre and Sidon became wealthy, luxurious, and effeminate. Some of their citizens saw in Africa a richer soil and a better situation for a large city, and founded Carthage. The Carthaginians inherited the trade of Tyre and Sidon, and in addition opened highways to Egypt and into the interior of Africa, bartering their wares in Egypt for corn and grain and in Africa for ivory, gems and slaves. They planted colonies in Africa and Sicily, and for a time were successful rivals of Greece and Rome.

The rule of the ocean transferred from Asia to Africa remained there but a short time, for the day of Europe came with the rise of Greece and Rome.

The Greeks founded colonies in Asia Minor, Sicily, and Italy. The ruins of great cities with Grecian temples and amphitheaters are found at Girgenti and Syracuse in Sicily, at Pæstum and other places in Italy. Under Pyrrhus, their armies were defeated by the Romans and her colonies captured. Deprived of these, her power rapidly declined and she became a Roman province.

ROME.

Rome founded few colonies, but she conquered the nations of Asia, Africa, and Europe, and brought under her sway kingdoms and empires. She boasted of five hundred cities in her Asiatic province that had been founded or enlarged and beautified by the Cæsars. One hundred and twenty vessels each year brought the goods of India from the delta of the Ganges, and large fleets from Egypt came laden with corn and grain. She imported from every country, but exported little, paying for her imports by taxes levied on her colonists.

Rome was the first power to incorporate conquered states into her dominion and extend citizenship to all the people in her empire, so that Paul could say in truth, "I am a Roman citizen and to Cæsar I appeal." So salutary and beneficial was her rule that under it these countries prospered more than under their own rulers. What Rome seized with strong hand she defended, and in return for taxation gave protection. She has no more enduring monument than her roads, the remains of which are now found in every country of Europe. Though built as military and post roads, they were used largely for commerce. All started from the golden milestone in the Forum; one ran over the Brenner pass northeastward to the Baltic Sea, another followed the northwestern coast of the Mediterranean to Spain and southern France, another crossed the Alps and extended through France to the British channel and through England to Scotland, where the Romans built a wall, ruins of which now bear witness to its strength. Another way went southward to Naples and Brindisi, and another led eastward to Macedonia and Greece. As these were the only roads in all these countries, it was truly said, "All ways lead to Rome;" and over them the messengers of Cæsar traveled more rapidly than the mail carrier of our fathers on our mail routes.

* Presidential address before the National Geographic Society, Washington, 1892.

VENICE AND GENOA.

After five hundred years of empire Rome fell, and the dark ages followed. From A. D. 400 to A. D. 800 commerce and trade died out. The only vessels on the Mediterranean and Baltic were piratical crafts; Jerusalem and the Holy Land were captured by the Turks; the crusades began, forerunners of a higher civilization and more extended commerce. Thousands and tens of thousands of people from all parts of Europe and all ranks of life, bearing the pilgrim's badge—the blood-red cross—journeyed toward the Holy Land, first in vast crowds led by Peter the Hermit, then in great armies led by kings and generals. For two hundred years this movement continued. Venice and Genoa furnished ships to carry the armies of France from Italy to the Holy Land. The Venetians were shrewd merchants and drove hard bargains, stipulating for cessions of land at the best commercial points and adequate compensation for their services. After the failure of each crusade they brought back remnants of the troops and pilgrims, and with them the products of Asia Minor, and books and art treasures from Greece. These were distributed all over Italy, and led to the renaissance of the thirteenth and fourteenth centuries.

The trade with the east brought power and wealth to Venice and Genoa. They founded colonies on the Black Sea in Asia Minor, and on the Asiatic coast. Venice alone had three thousand merchant vessels. Their commerce was not confined to the borders of the Mediterranean, for the goods of the Orient were distributed by the way of Augsburg and Nuremberg to the interior of Germany and to the towns of the Hanseatic confederation. Thus commerce was opened with the interior of Europe. By the failure of the crusades the power of the Turks, which had been for the time checked, grew and increased. They conquered the holy places of the earth, Asia Minor and Syria, and finally, crossing into Europe, gained Constantinople. The colonies of Venice and Genoa were captured; their fleets disappeared from the Mediterranean. In western Europe the Spaniards under Ferdinand and Isabella conquered the Moors, who for many ages had occupied the larger portion of Spain; and as the crescent appeared in eastern Europe, the cross triumphed in the west.

SPAIN AND PORTUGAL.

Then a new power appeared upon the stage. Spain and Portugal entered upon an era of exploration and discovery in regions unknown to Venice and Genoa. Commerce, which in the middle ages had been confined to the Mediterranean Sea, was now extended to the countries on the Atlantic Ocean, and the Cape Verde Islands, Madeira, and the Canaries were discovered. In one generation (between 1470 and 1500 A.D.) more and greater discoveries were made than in any other period of the world's history. The Portuguese sailed along the eastern coast of Africa and rounded the Cape of Good Hope; Vasco de Gama crossed the Indian Ocean to India; Columbus sailed westward to find the Orient, and discovered a new world; Magellan circumnavigated the globe; Balboa crossed the Isthmus of Panama and was the first to see, on the same day, the sun rise out of the Atlantic and set in the Pacific; and soon the eastern and western coasts of America were explored from Newfoundland to Cape Horn and from Cape Horn to Panama.

Both Portugal and Spain claimed all the new world, and as they could not agree upon a division of territory, they referred the matter to the pope, who divided the new world between them. The Atlantic became the great highway for commerce, while the Mediterranean was deserted, and Venice and Genoa existed only in the past.

The commerce of Portugal was coextensive with her dominion, which extended from Japan and the Spice Islands and India to the Red Sea, thence to the Cape of Good Hope; and with their possessions on the eastern and western shores of the Atlantic and in Africa and Brazil completed their maritime empire, the most extensive the world has ever seen. Then a single fleet of one hundred and fifty to two hundred and fifty caracks sailed from the port of Goa to Lisbon; now there sails but one vessel a year from all India.

From Spain ships sailed both to the Caribbean Sea and to Cape Horn and thence to Chile and Peru, or directly northwestward from Cape Horn to the Philippine Islands. Spain conquered Mexico, Central America, and all South America except Brazil. The gold and silver of Peru and Chile and the goods of the Orient were brought to Spain and Portugal. As their wealth and power increased the spirit of exploration decreased, and for nearly two hundred years the Spanish ships sailed in a fixed course by the same lanes, exploring the ocean neither toward the north nor the south, leaving undiscovered the great continent of Australia and numerous groups of islands.

The Spanish and Portuguese leaders were cavaliers who despised all commerce excepting in gold and silver, all kinds of manufactures, all manual labor, and the cultivation of the ground; they came, not to colonize, but to satisfy by the labor of the enslaved aborigines their thirst for gold and silver. The whole political power was retained by the king of Spain and administered by Spaniards. While the silver and gold of America and the wealth of the Indies poured into the treasuries of Spain, they wanted nothing more. Like ancient Rome, they took all the wealth of the conquered countries, making no return; but they did not, like Rome, give wise and equitable laws and a stable government to the countries they conquered.

THE NETHERLANDS.

The inhabitants of the Netherlands were manufacturers, and supplied the markets of Spain and Portugal and their colonies, thus reaping as large profits from their trade with these countries as the Spanish and Portuguese from the mines of gold and silver.

No part of Europe, says Motley, seemed so unlikely to become the home of a great nation as the low country on the northwestern coast of the continent, where the great rivers, the Rhine and Scheldt, emptied into the North Sea, and where it was hard to tell whether it was land or water. In this region, outcast of ocean and earth, a little nation wrested from both domains their richest treasures.

The commerce of the Hanseatic towns, which had depended for their trade on Venice and Genoa, became less and less as the glory of those cities waned. Antwerp, with its deep and convenient rivers, stretched its arms to the ocean and caught the golden harvest as it fell from its sisters' grasp. No city, except Paris, surpassed it in population, none approached it in splendor. It became the commercial center and banker of Europe; five thousand merchants daily assembled on its exchange; twenty-five hundred vessels were often seen at once in its harbor, and five hundred daily made their entrance into it. The manufactures of Flanders and the Netherlands had been noted for many generations, and now vastly increased and were distributed all over the world. The Netherlands, though the smallest, became the wealthiest nation of Europe. Then came the long-continued war with Spain, ending in the siege and fall of Antwerp and in the imposition of such taxation as no other country had ever endured. As Antwerp had grown on the ruins of the Hanseatic towns, so her fall became England's gain.

FRANCE AND ENGLAND.

In America, north of Mexico, neither silver nor gold had been found to tempt the Spanish and Portuguese. The larger portion of the northern Atlantic coast was one long sand beach, broken by great estuaries and the mouths of great rivers; the rest was rocky and rugged, the temperature generally cold, the land unfertile and barren. For these reasons North America was left to the French and English. The French claimed Canada and the whole of the territory of the United States save a narrow strip of land on the Atlantic coast. The French population was small and was made up principally of fur traders and half-breeds; Great Britain held New England, Virginia and the Carolinas.

After the first fever of religious colonization had passed, about the commencement of the eighteenth century, there was scarcely any emigration from England to America, and but little trade between the two countries. The population of North America was small, its commerce less, with little profit to the European merchants. The country possessed no peculiar advantages for the production of articles of value in foreign markets; there was nothing, therefore, to invite immigration or commerce.

The chief inducement to the English to navigate the Atlantic was the hope of capturing the treasure-laden Spanish galleons and the rich Spanish cities.

Sir Francis Drake, Sir Walter Raleigh, and other navigators, aided by Queen Elizabeth, with bands of buccaneers, refugees from all countries, though mostly Englishmen, explored the recesses of the Caribbean Sea, crossed the Isthmus of Panama, and launched their little vessels on the Pacific. In fifteen years they captured five hundred and forty-five treasure ships, sacked many towns, trained the English seamen, and laid the foundation for the navy of Great Britain.

The growth of English commerce was slower than that of Spain, Portugal, or Holland, and it was not until the middle of the eighteenth century, or two hundred and fifty years after the discovery of America, that she entered upon that career which gave her the control of the ocean. Her commerce was built up by protective laws, founded on the navigation act of 1651, which prohibited foreign vessels from carrying to or from England the commerce of any country but its own. These laws were universally regarded as among the chief causes and most important bulwarks of the prosperity of Great Britain, and they were continued until English ships controlled the carrying trade of the world, and were not finally repealed until 1854.

The mechanical devices of Watt, Arkwright, and other great inventors gave to England that supremacy in manufactures which she has ever since retained. The French revolution a little later aroused the fear of the statesmen, merchants, and capitalists of England that the energy of the new republic would be as omnipotent in mercantile affairs as on the field of battle. They believed that France might regain the colonies and with them the commerce she had lost, and, therefore, England declared war against Napoleon, which was carried on almost continuously from 1793 to 1815. The shipping of the continent disappeared or was captured by the fleets of England; the colonies, and with them the commerce, of Spain and Portugal, Holland and France, passed to England; and though she is still burdened with the debt then created, she has never lost the commerce and carrying trade she then obtained.

The population of the colonies of Great Britain is about one-sixth of the entire population of the globe; and their territory comprises eighty per cent. of the available temperate regions of the earth belonging to the Anglo-Saxon race.

The commerce of England has given wealth to her bankers and merchants, and employment to her artisans, shipbuilders, ironworkers, miners, and manufacturers. Her exports of produce and manufactures have increased five hundred per cent. in fifty years, or from $356,000,000 in 1840 to $1,577,000,000 in 1890, and are carried by her ships to every quarter of the globe. Though depending on America for her food supplies, these are moved in British ships. The commerce of the world pays tribute to the bankers of London and makes that city the money center of the world. Her best market is India, and from India comes her largest imports; next to these from the United States.

INDIA.

Egypt, Nineveh, and Babylon in prehistoric times, Tyre and Sidon and Greece under Alexander, Carthage and Rome under the Cæsars, Venice and Genoa in the middle ages, Portugal and Holland, and lastly England, have drawn great stores of wealth from India.

From India science and literature were handed on to Europe, and from India has come the religion of more

than half of the human race. For India the Spanish sailed westward; for India the Portuguese sailed eastward; Portugal was the first to reach the goal and obtain the prize. Greater riches have been drawn from India than from the gold and silver mines of America, since for all ages it has been the storehouse from which treasures were derived. Portugal held India from about 1500 to 1600. Ships brought the silks and precious stones of India to Lisbon, where they were sold to the Dutch and distributed by them through Europe. Spain conquered Portugal, and to avenge herself on Holland excluded her merchants from Lisbon. They then sailed directly for India, dispossessed the Portuguese, and the commerce of India was for the next hundred years controlled by Holland.

Then for a short time India was divided between France and England, but under Lord Clive and Warren Hastings the possessions of France passed to the East India Company, and when their charter expired it was made a province of the crown and the Queen of England became Empress of India.

Unlike Rome and Spain in their dealings with conquered nations, England gives a fair exchange for all she takes, and rules in India for India, giving a more stable and equitable government than India ever before enjoyed.

To-day Tyre, Sidon, and Carthage are known only by their ruins; the glory of Greece and Rome, of Venice and Genoa, has passed; the power of Spain and Portugal has waned, while India is developing a social, moral, and political prosperity, with wealth and commerce unknown in any former period of her history.

SUEZ CANAL.

Much of the trade of India in ancient times passed through a canal connecting the Red Sea with the Mediterranean, the remains of which still exist, and efforts to reopen it have been made at different times by Egypt without success. In 1856 De Lesseps obtained concessions from the khedive for the Suez Canal, and commenced the work under the direction of the best engineers of Europe. De Lesseps applied to English capitalists for help, but they were deterred by Lord Palmerston, who said he "would oppose the work to the very end." Mr. Stevenson, the engineer, supported Lord Palmerston, declaring that "the scheme was impracticable, except at an expense too great to warrant any expectation of returns." The emperor of France lent his name to the company, and large sums of money were raised in France; but the canal was constructed mainly by the money and laborers of Egypt. It was opened in 1869, and immediately English steamers began to sail through the canal, and the route around the Cape of Good Hope was almost abandoned. Other flags soon followed, and the commerce with India and the east, so long lost to Venice and the ports of the Mediterranean, was revived.

In 1875 Lord Beaconsfield purchased for England a controlling interest in the Suez Canal, and England now rules both Egypt and the canal. The vessels of all the maritime nations of the world are constantly passing through the canal, with the single exception of those of the United States.

COLONIES.

The commerce of the great nations of the world has been principally with their colonies or dependencies, and from this commerce they have derived their wealth. The mother country in return for its real or nominal protection, and for its own aggrandizement, has restricted the commerce of her colonies.

The European nations adopted four classes of restrictions:

1. Restricting the exportation of goods from the colony except to the mother country.
2. Restricting the importation of goods from foreign countries into the colonies.
3. Restricting the exportation or importation of goods excepting in ships of the mother country.
4. Restricting the manufacture even of their own raw products by the colonies. So strong was this feeling in England that even Lord Chatham declared in Parliament, "The British colonies of North America have no right to manufacture even a nail or a horseshoe."

Most of these restrictions have been removed, though the result still remains.

The Phenicians, Carthaginians, and Greeks had colonies on the Mediterranean. The Romans conquered and held as subjects, nations and empires. Venice and Genoa had colonies on the Black and Mediterranean Seas. Spain and Portugal held as dependencies all Central America, South America, Africa, India, and the islands of the Pacific. The Dutch republic and France planted colonies in India and America. England has colonies in every part of the world, and on her dominion the sun never sets.

Germany, France, Portugal, and Russia, appreciating the necessity of colonies for the extension of their commerce and for opening new markets for their manufactures, are planting colonies, France in Cochin China, Germany on the eastern and western coasts of Africa and the islands of the Pacific. Portugal, aroused to a new life, is determined to hold her remaining possessions in Africa; Russia is steadily adding to her dominions in Asia, and her railway from the Caspian Sea to Samarcand has opened in western and a part of central Asia a market for her manufactures and commerce hitherto supplied by Great Britain.

UNITED STATES.

The United States is the only nation that has become great without colonies and without foreign commerce and shipping. Its vast extent of territory, where the east and west, the north and south, are separated more widely than the colonies of Tyre and Sidon, or of Carthage and Rome from the mother countries; the great variety of climate, the fertile soil, its varied occupations and manufactures, and a widely distributed population, have created an enormous inland commerce and given that trade and wealth which other countries find in commerce and exchange with their colonies. Our population, wealth, internal commerce, exports and imports have increased at a more rapid rate than those of any other nation in a similar period. This is not due in any great degree to immigration, for our population has increased in no greater ratio since this immigration commenced than before, and experts believe that it would have been as large and more homogeneous without immigration. We had at one time a large foreign commerce, and our merchants were the first to establish direct trade with China and the East Indies; the stars and stripes were seen floating on every sea and flying in every harbor, and for years we were the second maritime nation of the world.

The commerce of the world passed from wooden sailing ships to side-wheel steamers, to iron and then to steel propellers; England was a worker in iron and machinery of every kind, we were not. The civil war came and hastened the day which was sure to come. Our shipping faded away faster than it had arisen, while that of Great Britain increased as rapidly as ours decreased. This was not owing to a decrease of our foreign trade, for during the last twenty years our exports and imports have increased more than twice as rapidly as those of Great Britain.* Eighty-seven per cent. of these exports and imports are carried in British ships, consigned to English houses, which have been established in every large port in the world, and the proceeds are usually remitted to the London banker.

Fortunately, our flag never disappeared from our inland waters and from our coasting trade; for foreigners are excluded from the coasting trade, even where the ports are fifteen thousand miles apart by water.

The substitution of steamers for sailing ships and of steel for wooden propellers, which took place from ten to twenty years ago on the ocean, is now going rapidly on upon our lakes. Where in 1886 there were but six steel propellers now there are 68; and of 2,225 vessels on the northern lakes, 1,153 are steamers, 902 are sailing vessels. The action of Congress in providing for the construction and equipment of war vessels by competition has led our ship builders within the last eight years to establish ship yards and machine shops where the largest ships can be built, and we are now building as large and fast vessels of war as England. Our ship builders claim that they can construct ships equal in carrying capacity, speed and strength to those of Great Britain, and at no greater cost; though they cannot be run so cheaply, because our sailors are better housed, fed and paid than those of other nations. The day will surely come when Commerce will make her last movement westward, when America, lying between Europe and Asia, with her boundless mineral and agricultural resources, her manufacturing facilities, her extended sea coasts, will be the foremost nation and New York the commercial capital of the world.

NICARAGUA CANAL.

From New York to San Francisco by land is about 3,000 miles, by water it is about 15,000 miles; yet, notwithstanding the greater distance, freight is constantly sent by water. From San Francisco it is about the same distance by water to either New York or London. If a waterway could be opened across the Isthmus of Panama from one ocean to the other, the distance from New York to San Francisco would be diminished more than one-half, and San Francisco would be over 2,000 miles nearer New York than London. The first proposition for canals connecting the two oceans was made in 1550, suggesting two routes, by Panama and Nicaragua; and explorations and surveys of both have been frequently made, and various attempts made for their construction.

The success of the Suez Canal induced M. De Lesseps to undertake the connection of the two oceans by the construction of the Panama Canal, believing that the tonnage passing through it would equal that of the Suez Canal. This work has not been successful; the canal remains unfinished, with no prospects of completion.

Several hundred miles north of Panama is the lowest continental divide; 148 ft. above tide water on the Pacific slope of this divide is Lake Nicaragua, connected by the river San Juan with the Atlantic; up this river and through this lake, some thirty years ago, was one of the regular ways of intercommunication, both for freight and passengers, between New York and California.

The Maritime Canal Company and the Canal Construction Company, organized by Americans, have obtained concessions from Nicaragua, and have made surveys for canal, slack water and lake navigation from Greytown on the Atlantic through Lake Nicaragua to Brito on the Pacific, a distance of 170 miles. A harbor has been opened at Greytown and considerable work performed on the canal. The Panama route had the great advantage of an open channel from ocean to ocean, whereas the Nicaragua route requires several locks to cross the divide; but Brito is some six or seven hundred miles nearer California than Panama, a saving in distance that will compensate for the delay in locking. The opening of this canal will be the greatest benefit that could be conferred upon our commerce and shipping.

Freights by water between New York and California are now so high that a large portion goes by railroad. The effect that this canal should produce will be evident if we consider the great difference in expense between land and water carriage. Rail rates between New York and Chicago are a trifle over six mills per ton per mile, while the ocean rates on grain to Liverpool in 1888 were about half a mill per ton per mile; and one mill per ton per mile, or three dollars per ton from New York to Liverpool, is said to be a fair rate, while the all-rail rate between New York and San Francisco averages from forty to eighty dollars per ton, according to the class to which the freight belongs. It takes from seven to ten days to go from New York to Liverpool, twice as long from New York to San Francisco by rail, thirty days by Panama, and one hundred and twenty days by the all-water route around Cape Horn.

The opening of this canal will therefore reduce the freight on goods between the east and west at least three-fourths and possibly more. It will give us a free, easy, and cheap communication by water between the Eastern and Western States; our commerce will be built up, and the wealth and commerce of the Atlantic coast and the population of the States on the Pacific coast will be increased in a wonderful manner.

The opening of this route will give a demand for large steamships, and when we have such ships, large ship yards and machine shops will spring up, and these alone are wanted to enable us to build and run ships on the Atlantic Ocean in competition with Great Britain. Then the prediction of Mr. Cramp will be fulfilled, that Englishmen will be asking one another: "Can we build ships as economically as they do in the United States?"

* The exports of the United States have increased 112 per cent., the exports and imports 92 per cent.; the exports of Great Britain 35 per cent., her exports and imports 37 per cent.

MODES OF CONVEYANCE.

The earliest transportation of merchandise was by caravans. The first caravan of which we have any certain account was that of the Ishmaelites and Moabites, who, while they were traveling from Gilead with their camels, bearing spices, balm, and myrrh to Egypt, bought Joseph of his brethren and sold him as a slave to Potiphar. These caravans were formed of merchants banded together for protection, under a guide and leader, sometimes numbering several hundred, with one thousand camels in a caravan. They traveled from seventeen to twenty miles a day, but only in the spring and autumn months. At night they stopped at caravansaries, where free lodging was furnished to men and beasts. In Turkestan and Arabia all trade and travel was by similar caravans until the railroad was opened across the desert by Merv and the Oxus to Samarcand.

Navigation was first by boat, and ages afterward by vessels. The earliest vessels of which we have any account were employed in carrying cattle down the Nile, and were propelled by sails and rowers. The vessels, at first small and with a few rowers, were slowly increased in size and number of rowers until three, four, and even five banks of oars, one over the other, were used. They were often from 150 to 175 ft. long, and from 18 to 26 ft. in breadth, drawing from 10 to 12 ft. of water, and sometimes carrying two hundred rowers and several hundred men.

All these ships were without decks, whether sailing on the Mediterranean or Atlantic. They sailed by day, putting into harbor at night, and never losing sight of land unless driven by stress of weather. At first they sailed only with the wind, but by slow degrees they learned to tack; then decks were built over the stern and prow, leaving the midships exposed to the high seas. This class of vessels, sometimes with banks of oars, continued until the middle of the last century.

In the early part of the fifteenth century smaller but stronger vessels of better material were built for the voyages of discovery undertaken by the Portuguese. At this time also the mariner's compass was brought into general use, having been introduced from Arabia; eighty years later it found its way to England. Two of the vessels of Columbus were decked only at the prow and stern, and the three were manned by one hundred and twenty men.

The Armada of Queen Elizabeth was formed of merchant vessels fitted up as men-of-war, and not until the time of Charles the First were there any regular ships of war in England or, probably, in other countries.

Commerce was usually carried on by companies, with rules regulating the quantity of goods to be exported, so that the market should not be overstocked and unremunerative prices obtained. Sometimes the merchant was owner of the vessel, who adventured with his cargo and sailed in his own ship. The ships were constructed with little reference to speed, sailing forty or fifty miles a day.*

The steam engine came into use near the middle of the eighteenth century in England, and two generations passed before it was used on vessels. The first steamboat ran on the Hudson in 1807, in England in 1812. Then another generation passed before the ocean was crossed by the Sirius and Great Western in 1833. These ships sailed from seven to eight knots an hour. Ten years later iron ships were built; then came the propeller, the invention of Ericsson, followed by vessels built of steel, and lastly the City of Paris and Majestic, carrying fifteen hundred tons of freight and sailing five hundred knots a day or twenty knots an hour.

Until the present century all commerce between remote points was by water, excepting in the Roman empire. After the downfall of Rome there was neither commerce nor travel and no use for roads, the cost of transportation even for a short distance exceeding the value of the goods.

The railroad was introduced about the same time into England and America, and was rapidly extended into every country. The steam engine on land and water has revolutionized the methods of transportation and created a new commerce. "The movement of goods in a year on all the through routes of the world did not then equal the movement on a single one of our trunk lines of railroad for the same period." Formerly it cost ten dollars to move a ton of freight one hundred miles; now it can be moved thirteen hundred miles for the same sum. The grain and corn from our Western lands, then not worth the transportation to the seacoast, are now sold in London, and our prairies yield to the Western farmer greater profit than the grain lands of England yield to the farmer there. The land commerce created by steam probably exceeds to-day the commerce carried on the water.

The cost of moving freight by railroads varies greatly in different parts of the United States and in different countries. The highest cost west of the Rocky Mountains is two and a quarter times more than in some of our middle States. The average freight receipts per ton per mile in this country are $0·922, which is less than those of any other country, although the Belgian and Russian rates are not much higher. In England the rates are from fifty to seventy per cent. higher than in America, and in the other countries of Europe higher than in England.

In England and America the railroads are operated by private companies in competition.

In France railroads are operated by private companies regulated by law, the country being divided among different lines of road. Lines are constructed by private companies and run at rates fixed by the government.

In Belgium and Germany the principal roads are owned and operated by the government.

Our system has yielded the best results to the people.

The commerce which was in olden times transported only twenty or twenty-five miles a day is now moved five hundred miles a day by water and eight hundred

* The breadth was about one-fourth the length, and not until within forty years were the proportions of one-tenth or one-twelfth of the breadth obtained.

miles by land. Correspondence, then carried no faster than freight, is now borne by telegraph to the farthest ends of the world.

All these changes have taken place within a single generation; for our fathers could not travel any faster than Alexander or Cæsar. Steamships, railroads and telegraphs within that time have transformed all commercial transactions and the methods of commercial business. Formerly eight months were required to execute an order in India or China and obtain the return; now one day is sufficient. These commercial changes caused a revolution in the modes of business, and were the main factors which produced the monetary disturbances of 1873, the effects of which we yet feel, so long has it taken the world to adjust itself to its new relations.

THE FUTURE OF COMMERCE.

The commerce of the world originated in Asia; it was carried to Africa and thence to Europe, and from Europe to America. This movement can go no farther westward, for on the other side of the Pacific is China, which has successfully resisted every attempt of the European to encroach upon her domains, and India with its teeming population of two hundred and fifty millions, so that America, the last of the continents to be inhabited, now receives the wealth of India and Asia pouring into it from the west and the manufactures and population of Europe from the east. Here the east and west, different from each other in mental power and civilization, will meet, each alone incomplete, each essential to the fullest and most symmetrical development of the other. Here will be the great banking and commercial houses of the world, the center of business, wealth and population.

The end is not yet. Inventions are increasing in a geometric rather than an arithmetric progression. The limit of steam power has not been reached, for with a high temperature in the steam boiler the addition of a few pounds of coal increases the steam power so greatly that we are unable either to control or to use it.

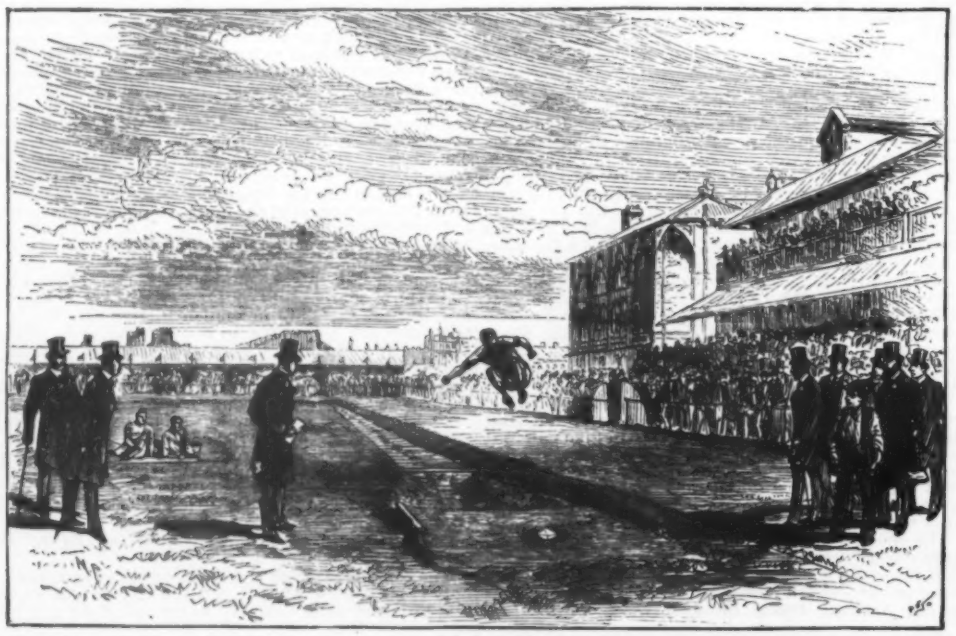
Electricity has just begun to offer new opportunities to commerce. We are no longer compelled to carry our factories to the water power, for by the electric wire the power may be brought to the house of the operative, and we may again see the private workman supersede the factory operative. A few cars and small vessels are moved by electricity—the forerunner of greater things. We know little of this new agency, but its future growth must be more rapid and more wonderful than that of steam.

The secretary of the Smithsonian Institution (Mr. Langley) tells us that "before the incoming of the twentieth century, aerial navigation will be an established fact."

"The deeper the insight we obtain into the mysterious workings of nature's forces," says Siemens, "the more we are convinced that we are still standing in the vestibule of science; that an unexplored world still lies before us; and however much we may discover, we know not whether mankind will ever arrive at a full knowledge of nature."

THE OXFORD AND CAMBRIDGE SPORTS.

THE competitive feats of the two rival universities on April 8, at the grounds of the Queen's Club, West Kensington, were as interesting to amateurs of athletic exercises on dry ground as the more popularly renowned boat race on the river. The most notable performance was that of Mr. C. B. Fry, of Wadham College, Oxford, in his long jump, 23 ft. 5 in., which is said to have beaten the record of jumps in Great Britain and Ireland. He also jumped 22 ft. 6¼ in., 22 ft. ⅛ in., and 21 ft. 8 in.; while Mr. H. M. Taberer, of Keble College, did 21 ft. 7 in., and two of the Cambridge men exceeded 20 ft. The high jump contest was won by Mr. H. Le Fleming, of Clare College, Cambridge, at 5 ft. 9⅛ in., an inch above Mr. E. D. Swanwick, of University College, Oxford. In the foot racing, Mr. W. E. Lutyens, of Sidney Sussex, Cambridge, won the mile race, time 4 min. 24⅘ sec.; the 100 yards race was won by Mr. A. Ramsbotham, of Exeter College, Oxford; the quarter mile by Mr. C. J. B. Monypenny, of Jesus College, Cambridge; and the hurdle race by Mr. H. Le Fleming, of Cambridge. In "putting the weight" to the greatest distance, Messrs. White and Miller, of New College, Oxford, far surpassed the Cambridge men; but Mr. H. A. Cooper, of Trinity Hall, Cambridge, outdid all others in throwing the hammer. Reckoning all the events together, Cambridge achieved one victory more than Oxford in these trials of agility and strength.

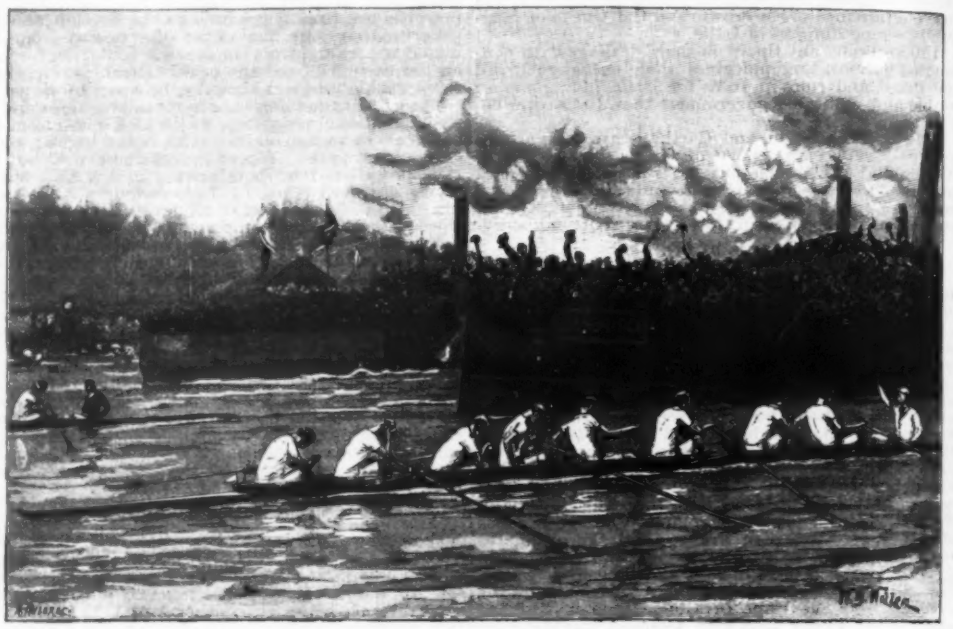


OXFORD AND CAMBRIDGE UNIVERSITIES' ATHLETIC SPORTS—THE RECORD LONG JUMP, 23 FT. 5 IN.

THE ENGLISH UNIVERSITY BOAT RACE.

THE most ancient waterman at Putney could find no fault with the weather on April 9, the day for the Inter-'Varsity Boat Race. Almost from the dawn the great throngs of al fresco showmen, with the hordes of gamins, up at daybreak to answer the roll call of pleasure, prophesied that it would be a day to remember—a day to become historic in the annals of aquatics, and these were disappointed in nothing. With the fuller power of the sun came a sweeping May-morn wind, eddying the little breakers under the arches of Putney Bridge, rolling them over and over the mud flats of the Surrey shore, folding flags on the Thames, Leander, and London boathouses into a hundred shapes, playing a merry game with the first of the swift flood. And as the hours slowly passed, and the promise which the dewy haze of the dawn had given became the performance, it was manifest to the aquatic encyclopædia, standing under the shadow of the great Thames boathouse, that even under the letter "p" or the page "past" he would find nothing to surpass that which was shortly to be recorded. From eight o'clock every minute brought its quota to the fray. The shouts of the hoary-headed deceivers of youth, anxious to present costly luxuries for a mere song, began to resound over the water. Launches with their grime shamed beneath a coat of tar, with their bunting looking really bright in the flood of sunlight, passed by in numbers to the Ship or the Limes. Great barges, which had just discharged their quantums of bricks or coal, leered under the load of smart youths endeavoring to master the mysteries of concertinas. It was the best phase of a scene often described, yet rarely to be witnessed as it was witnessed on Saturday—a great demonstration, progressing to its zenith when ten o'clock came; and from Putney to the bend the Surrey shore was alive with humanity; and the tideway bore on the swift flood every form and color and shape of craft which is known to the Thamesider. Nor was the mock pageantry of the spectacle lacking, for the motley was worn in a gondola from Venice yonder, and the touts of commerce cut their capers in hired launches, thrusting the notice of their wares under the noses of the pilgrims, and regretting in nothing their obvious intrusion.

The crews were up early, of course. Even before half-past nine a stout bevy of constables made way for the "Rough" of the Dark Blues to be pushed off the London hard; and shortly after the Cambridge Eight came out for the five minutes' experimental travel to see if slides and ores were as they should be. But, all being right, the men got into their sweaters and blazers again, and little was seen of them until the hour before the race. Long ere this it had been very evident that the flood would be a fast one, and that the beneficent breeze would neither mar nor greatly help the demolition of record. The water showed an amiability



THE ENGLISH UNIVERSITY BOAT RACE.

all-surprising under the really fresh east wind. The sun became almost trying in power as eleven o'clock passed, and the whole picture of the reach from the bridge to the bend was such as one looks for in the South rather than in a land of tantalizing meteorological vagary and eternal humidity. Even brighter were the conditions at midday, when the last of the flotilla, grimed, respectable, and even gaudy molecules making the mass, had passed toward Hammersmith, and the well-laden steamers stood hissing by Putney pier. The enthusiasm, ever hushed at such a moment, among a crowd nigh as nervously anxious as the pale-faced "fresher" who declares from his boots that he never felt jollier, was all lacking when the Light Blues got out their "Clasper" and put off to their wherry. The cheer was the cheer of Dotheboys Hall when the Dark Blues followed; but it was no lack of good will. The crowd was hushed because it wanted to lose nothing of the start, and the silence was so great that those on the bank declare that they heard Mr. Willan's stentorian, "Are you ready?" and the lusty negative from a lax and unexcitable Cantab. Be that as it may, the start was certainly delayed a moment, and in that moment the Oxford Eight poached all-valuable feet. As they slipped from their wherry at a stroke of thirty-nine—forty for the first half-minute—they had half their canvas before their rivals, and there was a dash and length about their rowing contrasting markedly with that of the Light Blues. The oldest critics on the Cambridge boat could not then suppress the muttered lament and painful pessimism. One look told them that Elin had cast logic to the winds, and was at his old fault again. "Six" and "seven" never had a chance for the first mile; "five" floundered in his painful efforts to get a finish; the bow oars, with a calm appreciation of circumstances, rowed as long as stroke would let them, and trusted the rest to sheer strength. The result was evident before the Thames boathouse was reached. Inch by inch, length defeated strength; even at the slower stroke of thirty-four, whereat the Cantabs did so well in practice, Elin could not give his heavy weights a chance at the finish. Pitman, on the other hand, was rowing with a freedom and a form worthy of his brother and of Oxford tradition. Fletcher and Rowe were backing him up in a way that reminded one of Buck and Brown; Cotton at bow, who was to have laid down the oar at the Crab Tree, rowed with a vigor delightful to see. So did Oxford shoot the mile post in 4 min. 1 sec., leading evidently, but still more evidently having the race at their mercy. The plucky spurt made by the Cambridge stroke off Rose Bank elicited shouts of Light Blue approval, but deceived no expert. For some dozen strokes alone did he let his men finish it out cleanly; then came the rush and the "bucket," and as the crews got straight for Hammersmith, Oxford were leading by a good half length, and made the Suspension Bridge in the record time of 7 min. 23 sec. Little good was it that the station served Cambridge by the Oil Mills, and that Elin quickened again and again with a pluck worthy of all praise. Those ten minutes had undone all that Mr. Muttlebury had done by three weeks' hard coaching. The "clip" and the "bucket" had demoralized the Light Blues beyond redemption. Two or three ugly rolls and a fountain of back water told the tale more clearly than any field glass analysis, and when Oxford reached Chiswick Church in 11 min. 40 sec., a length and a half ahead, all was truly over. From this point the winners did but paddle in, their opponents struggling on under that most fateful conviction, no sign of the enemy. It was on the plainest sufferance that the Dark Blue win was not of five lengths rather than of two and a half; and

their record time for this race—19 min. 21 sec.—although much due to the flood and to the peace upon the waters stamps the excellence of the crew and the speed of the race. The better men won undeniably, but it would have been a greater race, a race to have been remembered, if the Light Blues had not been demoralized from the start, and had their stroke only done in the contest as he had lately done in practice. Both crews rowed with the greatest pluck, and the plausible excuse that the Cantabs were overtrained was sheer nonsense, for their defeat was in the main due to the simple fact that they met better men, and altogether failed to do themselves justice.

It should be recorded that the attendance on the riverbank, on the house tops, and upon the tideway surpassed any that has been remembered by this generation; and that the hosts of the Lyric Club at Barnes, much comforted by martial music and luncheon, enjoyed themselves at St. Ann's as they have rarely enjoyed themselves in their history. So, too, at Ranelagh did society gird itself to al fresco delights, and find enthusiasm for pony racing when that for the "blues" had been forgotten.—*Illustrated London News.*

A RAT TRAINER.

DOUROFF, the rat trainer, who is exhibiting in Paris, is very interesting as seen in the evening at the theater under a flood of electric light; but a more enticing study is that of the individual divested of his stage furbelows and returned to the state of head of the family—of a family of several hundred rats. Douroff

TRAINING A RAT.

has, according to the hand bills, 230 rats. It will be conceived that these figures are subject to fluctuations. Escapes and maladies are compensated for by new recruits, the inevitable results of promiscuousness. The number of young produced at a birth is, on an average, fourteen, and these are subjects for the future—the best and the most docile. The outside rat is obtained by capture; so Douroff has Russian, German, Spanish, white, variegated and gray ones. In two hours of detention, fasting and caresses, he makes an approachable subject of his captive. It is then that he studies its character, its faculties, and the tractability of its disposition. There are rats as there are human beings; there are intelligent ones and stupid ones, gentle ones and fierce ones, sociable ones and otherwise. Douroff sorts, selects and operates in consequence.

We have rarely had so startled a feeling as on entering, for the first time, the menagerie where Douroff, his wife and his charming little girl dwell. One could not dream of anything having so much character, in a few square feet, as the home of Douroff or his room at the Folies Bergere.

At home (a hotel room), Douroff usually lives in bed, where he makes the acquaintance of his new comers and keeps up a friendly feeling in his entire troop.

Douroff, who is a Slavonian, we therefore find in bed,

a mode of existence that it is necessary to become somewhat accustomed to. Here are cages filled with rats, boxes used for carriage to a distance and the trunks of the itinerant family, as well as the accessories, from a railway up to baskets, houses, etc.—a lot of paraphernalia that the trainer has constant need of in order to keep his legions in training. On the mantel, a gray cat—the cat of the castle of poverty of *Captain Fracasse*—points its ears drolly in the direction of its master. Another, a beautiful tom-cat, with long black fur, has selected a domicile at the side of the bed and seems to be clothed with a paternal authority over the rats that are moving at leisure around the room.

Finally the bed: Douroff, leaning on his elbow, is making his pupils work. At his side is his little girl, scarcely three years of age, abandoning herself unconsciously to the rodents, which run over her body and dispute particles of biscuit with her lips. On the bed, a white and black greyhound lies asleep.

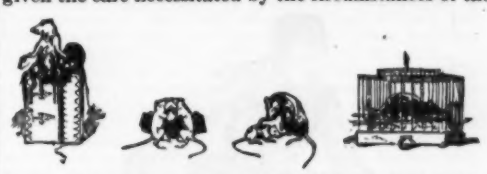
The basis of Douroff's treatment is gentleness. If he speaks to his animals it is always in a low voice, with caressing inflexions. He never touches them. His hand serves solely to direct, to "encourage." At the end of the work to be performed, they get a reward—grain, bread, or some dainty.

In a few hours the wildest rat is tamed, and in a very short time, too, Douroff will have trained it to perform the most varied exercises—to pirouette on his fist, to play the beau, and to obey him. In a few days or never: the rats rebellious to all instruction are relegated to the stock of supernumeraries. Rats have a very decided character. There are some that Douroff has never been able to keep in confinement. These are true poets, the sons of starry night that wish to live free and to their fancy. There are some of them from which Douroff takes his first subjects, that are fine, pleasing, skillful artists.

There are rats that live in families, in groups of thirty and forty, and which cannot tolerate being

mixed. There is a special cage for them. The others are kept apart. And never does one of them make a mistake; each enters his own domicile.

There are bad rats that pass their time in causing scandal. There are sick ones, and for them there is an infirmary consisting of a small cage, and to them is given the care necessitated by the circumstances of the



case. The great remedy of the *Malade Imaginaire* would be useful in many cases. The lacteous treatment replaces it, and excites the gratitude of the patient. While Douroff is initiating us into these mysteries, a hospital rat literally lays hold of his master while passing. "Ah! I know what it is," says Douroff; "a little rubbing with glycerine, that is all!" And the trainer proceeds to rub the little animal, whose look of satisfaction is most amusing.

PASSENGERS BOARDING THE TRAIN.

Douroff's room at the theater is after the same model as his living apartment; always the rats running at their fancy, and always the cats, their companions.

In order to appreciate the patience of the trainer, it is necessary to have been present at one of his exhibitions at the theater. Douroff has conceived the idea of causing his entire troop to travel on a mechanical railway, the first sight of which astonished us. He establishes upon the floor of the stage a circular track fully sixty feet in circumference, with tunnels, station, semaphore, and a train of several cars coupled to a locomotive. With movements of infinite gentleness, he directs the rats upon the platform serving as a vesti-

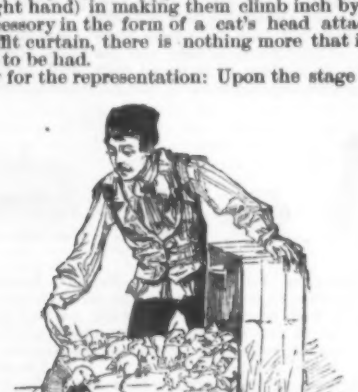
FOR THE NIMBLEST CLIMBER.

DOUROFF IN HIS ROOM.

bule to the station. He makes them come out of their cage, caresses them, gives them their cue, and persuades them so well that each keeps to his role without causing a perturbation among the troop. One rat is trained to run toward the locomotive. He is the engineer, and his colleague, the fireman, follows him. The tender is filled, and then the passengers enter the cars. One actor raises the lantern of the semaphore, and two or three others (passengers) seem to be feverishly seeking a refuge toward the station. They discover the beneficent inscription "For Men" and disappear. Still another passenger, a mamma, all white, with her young ones trotting after her. The station fills, and heads are seen in every story. The clock strikes and the train starts, and finally returns to its starting point without accident.

The apprenticeship has been long, troublesome, and beset with thorns. But when Douroff has succeeded (on tapping with the left hand the rats that have approached a pole, and on presenting them a seed with the right hand) in making them climb inch by inch to an accessory in the form of a cat's head attached to the soffit curtain, there is nothing more that is astonishing to be had.

Now for the representation: Upon the stage we see



AFTER THE REPRESENTATION.

an inclined plane in the center of which there is an extinguished lamp with a red globe. In the penumbra appears a black cat, which climbs up to the lamp and lights it with a stroke of the paw. Then Douroff enters in the costume of a scholar of the middle ages. He plays with the cat, and then he takes a blowpipe and draws sounds therefrom of a very primitive rhythm.

"A rat!" exclaims some one in the hall. Yes, a rat is emerging from the side scenes, and in a few minutes afterward there are two hundred of them. Douroff confides some of them to the black cat for his diabolical recreation. Others pirouette and climb to the top of the theater. We shall not speak again of the railway, whose arrangement we have sufficiently described.

These hundreds of rats, coming no one knows whence, to the sound of a flute, and swarming about and suddenly disappearing, cause a sort of hallucination.—*Abstract from L'Illustration.*

THE LARGEST CATTLE RANCH IN THE UNITED STATES.

By RICHARD HARDING DAVIS.

THE largest ranch in the United States, and probably in the world, owned by one person, is in Texas, and belongs to Mrs. Richard King. It lies forty-five miles south of Corpus Christi.

The ladies who come to call on Mrs. King drive from the front gate, over as good a road as any in Central Park, for ten miles before they arrive at her front door, and the butcher and baker and iceman, if such existed, would have to drive thirty miles from the back gate before they reached her kitchen. This ranch is bounded by the Corpus Christi Bay for forty miles, and by barb wire for three hundred miles more. It covers 700,000 acres in extent, and 100,000 head of cattle and 3,000 brood mares wander over its different pastures.

This property is under the ruling of Robert J. Kleberg, Mrs. King's son-in-law, and he has under him a superintendent, or, as the Mexicans call one who holds that office, a major-domo, which is an unusual position for a major-domo, as this major-domo has the charge of 300 cowboys and 1,200 ponies reserved for their use. The "Widow's Ranch," as the people about call it, is as carefully organized and moves on as conservative business principles as a bank. The cowboys do not ride over its range with both legs at right angles to the saddle and shooting joyfully into the air with both guns at once. Neither do they offer the casual visitor a bucking pony to ride, and then roll around on the prairie with glee when he is shot up into the air and comes down on his collar bone; they are more likely to offer him as fine a Kentucky thoroughbred as ever wore a blue ribbon around the Madison Square Garden; and neither do they shoot at his feet to see if he can dance. In this way the Eastern man is constantly finding his dearest illusions abruptly dispelled. It is also trying when the cowboys stand up and take off their sombreros when one is leaving their camp. There are cowboys and cowboys, and I am speaking now of those I saw on the King ranch.

The thing that the wise man from the East cannot at first understand is how the 100,000 head of cattle wandering at large over the range are ever collected together. He sees a dozen or more steers here, a bunch of horses there, and a single steer or two a mile off, and even as he looks at them they disappear in the brush, and as far as his chance of finding them again would be, they might as well stand forty miles away at the other end of the ranch. But this is a very simple problem to the ranchman.

Mr. Kleberg, for instance, receives an order from a firm in Chicago, calling for 1,000 head of cattle. The breed of cattle the firm wants is grazing in a corner of the range fenced in by barb wire, and marked pale blue for convenience on a beautiful map blocked out in colors, like a patchwork quilt, which hangs in Mr. Kleberg's office. When the order is received, he sends a Mexican on a pony to tell the men near that special pale blue pasture to round up 1,000 head of cattle, and at the same time directs his superintendent to send in a few days as many cowboys to that pasture as are needed to "hold" 1,000 head of cattle on the way to the railroad station. The boys on the pasture, which we will suppose is ten miles square, will take ten of their number and five extra ponies apiece, which one man leads, and from one to another of which they shift their saddles as men do in polo, and go directly to the water tanks in the ten square miles of land. A cow will not often wander more than two and a half miles from water, and so, with the water tank, which on the King ranch may be either a well with a windmill or a dammed cañon full of rain water, as a rendezvous, the finding of the cattle is comparatively easy, and ten men can round up 1,000 head in a day or two. When they have them all together, the cowboys who are to drive them to the station have arrived, and take them off.

At the station the agent of the Chicago firm and the agent of the King ranch ride through the herd together, and if they disagree as to the fitness of any one or more of the cattle, an outsider is called in, and his decision is final. The cattle are then driven on to the cars, and Mr. Kleberg's responsibility is at an end.

In the spring there is a general rounding up, and thousands and thousands of steers are brought in from the different pastures, and those for which contracts have been made during the winter are shipped off to the markets, and the calves are branded.—*Harper's Weekly.*

A STEAMER CARRIED INLAND ON A WAVE.

TOURISTS that visit Batavia nowadays are quite out of the fashion if they fail to make the passage through Sunda Strait and see all that is left of Krakatua and the vestiges of the ruin wrought by the terrible eruption of 1883. If they push up the bay of Lampong, on the Sumatra side of the channel, they are likely to land on the low shores occupied by the village of Telokh-Betong, and hire carts for a short jaunt into the interior; and when they have gone about two miles they will pause to take in the curious scene presented in this picture; for here is seen one of the most interesting results of the great wave of Krakatua.

There was just one man amid all that wild scene of death and devastation who was not overwhelmed in the common ruin. He escaped while 40,000 perished. He was the lighthouse keeper, who lived alone on an isolated rock in the strait. It was broad daylight when Krakatua burst asunder, but in a few moments the heavens were so densely shrouded by dust, mud, and smoke that the darkness of midnight covered all the channel. The guardian of the lighthouse was in the lantern 130 feet above the sea level. Here he remained safe and sound in the midst of the terrible commotion.

HIGH AND DRY IN THE JUNGLE.

He felt the trembling of his lighthouse, but it was so dark that he could not see the threatened danger. He did not know that a tremendous wave had almost overwhelmed the lighthouse, and that its crest had nearly touched the base of the lantern. He did not hear it because he was deafened by the awful detonation of Krakatua.

In a few moments the wave, over a hundred feet in height, had swept along a coast line of 100 miles on both sides of the channel.

Scores of populous villages were buried deep beneath the avalanche of water. Great groves of cocoanut palms were leveled to the ground. Promontories were carried away. New bays were dug out of the yielding littoral. Every work of human hands except that lighthouse was destroyed, and 40,000 persons perished in the deluge that mounted from the sea or beneath the rain of mud that filled the heavens.

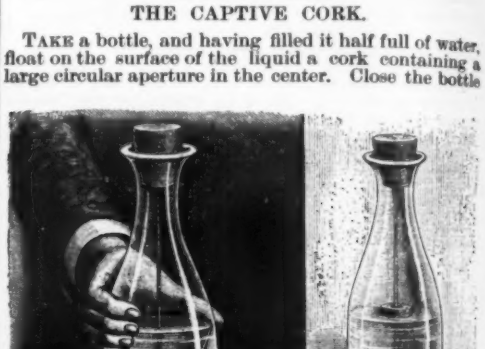
This is a picture of a little sidewheel steamboat that was borne on the top of that wave through forests and jungle, over two miles into the country, and was left as the wave receded in the position here shown. It will be remembered that, for weeks before the final cataclysm at Krakatua, the volcano was in a state of eruption. Pleasure parties were made up at Batavia to visit the volcano. Not a few people landed on the island, little dreaming that in the twinkling of an eye two-thirds of it was to be blown into the air as though shot from a gun. They wished to get as near as they thought they might safely venture to the growling, steaming crater. This little steamboat on the day before the explosion carried one of these parties to the island. There were only twenty on board besides the crew. They spent a couple of hours around the island, and then steamed up the deep and narrow bay of Lampong and it is supposed they anchored for the night in front of the big town of Telokh-Betong, which was one of the largest settlements on the south coast of Sumatra.

The ill-fated pleasure party was never heard of again. It is supposed that the boat was turned over and over like an egg shell in the surf. It had every appearance of such rough usage when it was found some months later. The machinery and furniture were badly broken, and were strewn about in the greatest confusion. But the vessel held together, and was finally set down in good shape, erect on her keel, as she is seen in the picture, which was made from a drawing by Mr. Korthals, a member of the Dutch scientific party sent out to study the effect of the Krakatua eruption.

Only two bodies were found in the vessel. They were of course below deck. As it was morning when she was picked up by the wave, it is supposed that nearly everybody was on shore. Not a vestige remains of the villages that lined the water edge. But the hulk of this little boat still stands, battered and broken, though as erect as when she plowed the channel, and she is the most curious and interesting relic of the greatest volcanic eruption of modern times.—*N. Y. Sun.*

THE CAPTIVE CORK.

TAKE a bottle, and having filled it half full of water, float on the surface of the liquid a cork containing a large circular aperture in the center. Close the bottle



THE CAPTIVE CORK.

with a cork into the bottom of which is inserted a knitting kneedle that passes through the floating cork. Now ask a person to disengage the latter from the needle without touching the cork that closes the mouth of the bottle.

The figure to the left gives the solution of the problem. Revolve the bottle rapidly and make it describe four or five circles on the table. Then leave it to itself.

It will be found that, through the effect of centrifugal force, the surface of the liquid ceases to be horizontal and forms a cone whose apex is very near the bottom of the bottle. The cork descends with the water along the needle and escapes as soon as it reaches the extremity.—*L'Illustration.*

FRESH WATER SHARKS—THE GREAT LAKE ESCOIDÆ.

By Dr. G. ARCHIE STOCKWELL, F.Z.S.

THE Escoidæ, or pike family, are well represented in the great lake basin, though it is doubtful if the true pickerel, *Esox reticulatus*, is found anywhere westward of Lake Ontario; the title is, however, indiscriminately applied to all the smaller Escoidæ, especially those of the lesser lakes and rivers of Wisconsin and Minnesota, while, *per contra*, the larger almost universally obtain the name of masq'allonge. In Michigan, particularly, every pike over five pounds weight and half a yard in length is a masq'allonge, the proper designation being employed exclusively to distinguish the gars, while from Lake Erie to the Straits of Mackinac the wall-eyed pike or pike perch, *Stizostedium Americana*, is generally known as "pickerel."

All true pike of the great lake basin, the masq'allonge and "great northern" variety of Louis Agassiz excepted, are, commonly speaking, river fish, or inhabitants of small still ponds, and these giant exceptions undoubtedly, from scientific and anatomical standpoints, are merely overgrown *Esox lucius*, just as the latter in turn is an exaggerated pickerel, since in osteology, myology, general physiological and physical outlines, habits and specific characteristics (including coloration and procreation), all these varieties practically agree, so much so that ichthyologists recognize the difficulties of differentiating the offspring of all, particularly the young of the larger from the adults of the lesser. As evidence may be recalled the fact that all works devoted to angling and ichthyology are suspiciously silent regarding this, a matter of considerable moment; also that pickerel, or *pikerel*, as was the original word, is merely a diminutive of pike.

The differentiation of the great northern pike of Lake Superior (*Esox estor*, *val borealis*) from the masq'allonge is now, I believe, pretty generally conceded as incorrect, or at least arbitrary and unnecessary, especially as the modern tendency of zoology as regards classification and nomenclature totally opposes reduplication and multiplying of species. This has long been a moot, somewhat vexatious, and greatly argued question, but the consensus of opinion favors in overwhelming majority simplicity and conformity, particularly as it tends to foster scientific study and research. The claim advanced that masq'allonge differ in certain peculiarities, aside from mere variations in size and color, from other giant pike has been by no means well substantiated. The statement, moreover, that masq'allonge alone possess uniform palatine and vomeral dentition, with total lack of, or at least undeveloped, teeth in the lower jaw anterior to the canines and posterior to the incisors, which latter are sometimes rudimentary, and that it exclusively exhibits partially naked cheeks and scaleless opercles or gill covers, is by no means borne out by facts. Such

appear rather as results of age and development, and are far from constant to any one of the larger species. Further, many individuals are wont to assert the existence of two distinct species of masq'allonge, which they denominate respectively *Esox immaculatus* and *E. nobilior*, simply because there is great lack of uniformity in fish taken from the great lakes proper, widely different markings appearing on those taken from the same precise locality, a phenomenon for which naturalists have failed to give adequate explanation. *Apropos* of their practical identity, I submit the following by Mr. Thomas Meredith, who is possessed of wide knowledge and experience extending over many years: "In Booth's fish market, Chicago, I recently examined two fish, one of each variety, and very nearly of a size; the spotted weighed twenty-two and the unspotted thirty-two pounds. They were the extremes of markings, clean and clear specimens, and *Esox nobilior*, in every point laid down by Jordan, in his 'Manual of Vertebrates of the Northern United States.' I made the remark the spotted form came from the Wisconsin system of waters, but the attendant corrected me, declaring both from Detroit, Mich. Consequently, neither could have come from the Badger State." [Probably they were taken in the Monroe marshes, or Maumee Bay, Lake Erie, the marshes of Grosse Pointe above Detroit, or the Flats of Lake St. Clair.—S.]

"Again I examined a dozen specimens that were known to have been taken in great lake waters, many of which were of neither variety, if markings can be held to constitute a guide, as some were but faintly thus characterized, others distinctly so, others of a decidedly plumbeous hue, with white bellies, and others again with the spots so confluent as to form across the body mazy mottlings. As a whole they varied as much in color and markings as do brook trout (*Salmo fontinalis*), yet they were all unmistakably true *Esox nobilior*. I am inclined to believe that in rivers and small lakes the masq'allonge do not vary, or at least but slightly, in markings; that in the Great Lakes proper all varieties of marking will be found; and that the extremes in differences are had in the St. Lawrence and Mississippi systems respectively. Consequently, the term *Esox nobilior* should remain unchanged, being equally applicable to all."

Commenting on the foregoing, Prof. David Jordan, of the Smithsonian Institution, writes:

"In the spotted masq'allonge the body is marked with numerous black spots; in the lighter variety it is nearly of plain lead color, or else clouded by darker. In the former the scales upon the cheeks are mostly confined to a belt about eight scales in width and about as broad as the eye; in the latter there are more scales on the cheek, forming a band much wider than the eye, and about twenty scales in width. . . . I am strongly inclined to believe Mr. Meredith is right, for it is unlikely there are two distinct species in the ordinary sense in which the word is employed by zoologists."

In the "Natural History of Aquatic Animals" issued in two large quarto volumes by the United States Fish Commission, Mr. Kumelein declares: "Masq'allonge are occasionally caught in the small bays indenting the south shore of Keeweenaw Point, Michigan (Lake Superior), as far as Huron Bay, and with it a larger and much lighter fish." And this I can corroborate of other localities from personal experience, notably points in Lake Huron, Georgian Bay, Lake St. Clair and river, and Black River, emptying into the latter. Further, the tendency of the species, especially in spring, is to associate by pairs, and I have seen the two varieties together, which perhaps is the strongest argument as to specific identity.

Naturalists have bestowed upon the masq'allonge the specific designation of *Esox nobilior*, the "nobler pike," though for what definite reason is not at all apparent, unless out of compliment to overgrowth and incongruity. In truth, he is one of the most villainous of fresh water inhabitants, a Shylock among sharks, the foe of all better food fishes, and ever eager to extort a "pound of flesh," regardless of sources or consequences as applied to others than himself. He well deserves the title of "distorted one," that obtains among Crees, Sateaux, and Nadoweese, for distorted he certainly is, both physically and morally, and withal is cool, calculating, selfish, crafty, vile beyond all measure of comparison.

It is to the early French colonists of Canada that we are indebted for his present popular designation, a compound of the words *masque* and *allonge*, signifying "long face," and which by sluggish and vulgar tongues has been transformed into "'lunge," "'longe," "maskalonge," "maskalunge," "muskellung," "maskalung," "muskilinga," "maskinonge," "maskenonge," etc., the last being an aboriginal sobriquet and corruption derived from association with French Canadians, voyageurs, and half breeds.

A mere glance at the creature is sufficiently convincing of the propriety of his Gallic pseudonym, and at the same time of his very near relationship to lower and reptilian forms of life. The long, lithe body of greenish or leaden hue plenteously besprinkled with darker, or even black; a dorsal fin in close proximity to the cauda; the tail suggestive of the undeveloped appendage of immature gars or "bill fish;" the relations of the eye and its orbit, including the malevolent, even fiendish expression of the former; the angular facial outline and crocodilian conformation of jaws and skull; the lower maxillary loosely articulated and capable of considerable and direct downward dislocation when necessary to enlarge the throat for the reception of prey; the supplementary ossification at the maxillary articulation, as in vipers; the vomer, palatines and pharyngeals, sectional and independent as to muscular relations, besides armed with strong recurved, retractile, card-like teeth, that are extended even to the base of the tongue; all evince a saurian tendency and close reptilian ancestry. Owen supposes the "throat teeth" in pikes play a part in digestion, either by mangling the prey while in transit down the gullet, or by subsequent disintegration following upon regurgitation, but the œsophageal conformation and relations in all the family preclude the latter possibility, and the peculiar arrangements are doubtless merely provisions to prevent the escape of victims after they are once seized. Atop of all, the flesh is most white, though with a slight azure tinge, as in edible lizards, of the same peculiar grain too, the habits more nearly those of aquatic reptiles than fishes proper, and the young of all the family require for their development and release from the ova the incubating influence of direct solar heat.

In life history the masq'allonge emulates the whole pike family; all are voracious, predaceous, omnivorous, piscivorous, the pest of the waters they inhabit, and where any considerable numbers congregate, the better classes of food fishes are "conspicuous solely by their absence." Personally I abhor the whole race, root and branch, for their vile, mendacious, cruel ways, and capture by hook or spear in each and every instance may justly be regarded as an act of sovereign retribution. There is nothing careless, frank, or open about any pike, as with other predatory fish, since he by no chance ever pursues his prey boldly, openly, or honestly; on the contrary, he is sly, sneaking, crafty, malevolent, contemptible, constantly lying in wait for unsuspecting victims, who are never under any circumstances anything like his equals in size, might, or cunning; incapable of offering any successful resistance, or even endangering the life of their persecutor, they for the most part are creatures of simple and inoffensive habits, who are pounced upon with more than lupine ferocity, and immediately rent into fragments or dragged off into some rayless, noisome lair in peat banks, in a hollow log, or beneath the water lily roots, there to be gloated over, tormented, and deliberately devoured by piecemeal.

The delight of all giant pike, whether of the masq'allonge or great northern variety, is the borders of sedges and marshes that afford dark and safe retreats, the lily beds where the broad leaves insure murky depths, or pools in which the wild rice flourishes in such profusion and luxuriance that its stalks form a subaqueous barrier, all but impenetrable to any other of the finny tribes, where the wild fowl resort to feed and rear their young, and from beneath whose somber shades he can deftly and silently poke up his long snout and size upon some tender and innocent duckling which disappears in the midst of a swirl of dark water to the amazement of the fond parent who, ever on the alert for danger, has no knowledge of foes beneath and in the element that she is accustomed to consider a source of safety and refuge. His rapacity is incarnate, for absolutely nothing comes amiss in the way of food that is flesh, fish or fowl, fur, fin, feather, or reptile, not even carrion, stinking offal, excrement, or other form of filth.

The spawning season is the springtime, from March until May, according to latitude or locality. Now the pairs resort to grassy and sedgy banks or overflowed bottoms, and seized with the *furor* of concupiscence, approximate their vents, rubbing bellies violently together, when, in the midst of a powerful orgasm manifested by tremendous sweeping of tails and quivering of bodies, the commingled milt and spawn are deposited. Simultaneously both turn to devour the ova, sedulously seeking the last particles—a happy provision of nature to prevent overstocking and consequent extirpation of better fish. The impregnated spawn that escapes is only that which, coming in contact with stalks and grasses, strenuously adheres thereto, and which with the subsidence or evaporation of the waters often may be observed at the surface, or just above or beneath, a fact which doubtless gave rise to the ancient superstition (not yet wholly eradicated) that pike are developed from aquatic plants through vernal heat and moisture, supplemented by solar rays.

In ten or twelve days in the more southern latitudes, and fourteen to eighteen in northern, provided the water recedes sufficiently and the meteorological conditions are propitious (otherwise the ova are spoiled), the young escape from their yellowish white and membranous envelopes, and a week later have lost the umbilical sac and begun to feed. Darting hither and thither, they pounce upon minute forms of aquatic insect life with puny but marvelous vigor, thus at early and tender age manifesting phenomenal ferocity and tendency to rapid development and growth that is witnessed in no other piscine race.

Prof. Von Benecke, the Prussian naturalist, declares of the European pike (*Esox lucius*), "a single fish of this family deposits one hundred thousand eggs, each three millimeters (about three-tenths of an inch) in diameter;" and Dr. E. Sterling, in the United States Fish Commission Report for 1872–73, says of a masq'allonge captured by him of which he made a plaster cast for the Smithsonian Institution: "It was two feet long, the eggs about the same diameter as those of a white fish, but yielding twice as many to the pound;" which would indicate Prof. Von Benecke's figures as applied to American forms are under rather than over the mark.

Isaak Walton wrote of the English pike: "He is observed to be solitary and melancholy, and a bold fish; melancholy because he always swims or rests himself alone, and never swims in shoals or in company; . . . and bold because he fears not a shadow, or to be seen of any one, as the trout, the chub, and all other fish do." However true this may have been at one time of the English pike, it is in but small measure applicable to masq'allonge or his great northern brother; and of *Esox lucius*, Yarrel in his "British Fishes" mentions an annual migration taking place in spring in the river Cam, "into which they come in great shoals, doubtless from the fens in the neighborhood of Ely, where they are bred." Major J. Ross King, too, in "Sportsman and Naturalist," corroborates Yarrel, adding, "I have often myself seen pike in company."

The boldness of the race is that of the coward only, for they are ever alert and suspicious, ready on the instant to turn tail. More than once when watching some form of pike, I have observed the jarring of ground or boat, the casting of a shadow even by a passing cloud, or a sudden ripple in the water, would send him scurrying in headlong haste to his lair, from which the most tempting bait could not lure for hours, perhaps. Neither is he solitary, the tendency as already remarked being to consort in pairs; but the error is natural, since but one of the couple prospects and scouts at a time, the other apparently lying in wait for developments. A more than usually tempting bait will sometimes coax both from concealment, but more often the second appears suddenly, and at the very instant it is apparent the suspicions of the first have been lulled; the one in hiding appreciating well the selfishness of the race, is doubtless apprehensive regarding its share of the tidbit if delay is further prolonged. The angler who is fully familiar with the traits and characteristics of the species, and cognizant of surroundings, with a little display of patience and judgment may usually secure a second fish from every pool. It can hardly be said they are gregarious, however, in spite of the authorities cited, since numbers associate only for a few days at some one season of the year, and then not by choice, but forced thereto by some community of purpose; and yet the many individuals that may sometimes, of a May or June day, be seen basking in some one particular area of water evidences the species is not so rare as is popularly imagined. But they do not, as a rule, lure well to the hook in midsummer, when food is abundant and prey easy of capture, and the taking of one or two specimens is apt to serve as a hint to all others in the immediate vicinity to avoid danger by hiding; further, they are really unfit for the table at this season. In autumn, however, in October or November, or after one or two sharp frosts, and when ordinary prey is becoming scarce and more difficult of capture, all pikes are prone in some degree to lose their customary caution, and yield to the baser temptations and caprices of appetite. Now a well placed bait will find takers, and I have often observed that a particular area that yielded no masq'allonge or pike in August or September, a few weeks later, especially after ice had formed, became as it were miraculously populous. Now, too, the flesh is firm, hard, flaky, and succulent of its kind.

After the spawning season, the Escoidæ apparently are possessed of no aim in life save securing means to gratify a bloodthirsty disposition and gluttonous greed. Gould declares he has known an *Esox lucius* to be choked in an attempt to swallow one of his own species too large to pass his gullet; and it is safe to say the smaller was likewise caught napping or otherwise taken unawares. According to Yarrel they devour voles and water rats. At Trentham, England, one seized the head of a swan that was feeding under water, and gorged so much thereof as to kill both; and Gessner asserts a famished pike in the Rhone seized the lips of a mule brought to the brink to drink, the latter drawing from the water ere it could disengage its hooked teeth; also that people have had their legs bitten and mangled by pikes when bathing.

This may for the most part be romance, but every one at all familiar with the race will not be inclined to wholly discredit. A correspondent of the *American Field* (vol. 27) vouches for a masq'allonge of twenty pounds being taken from the stomach of another nearly four times its weight, and I have personally seen a soft-shelled turtle removed from the gullet of a northern pike that was fully as large as the latter's head.

As to size and age of pikes, a great deal has been written, some of which is doubtless traditional and mythical. Old school books and works of natural history, of the last century particularly, were wont to give place to the tale of a pike taken at Kaiserlauten, near Mannheim, Bavaria, *nineteen feet long*, of three hundred pounds weight, and two hundred and sixty years old. There are, moreover, two versions of this "yarn." Hence either had best be taken *cum grano*. One that the fish was taken as above stated, the other that it was caught near Hailbrunin, Suabia; and the age of the former was determined by a gilded copper ring affixed to its fin bearing the inscription, "I am the first fish thrown into this pond by the hand of Frederick II., October 5, 1230," while the latter bore a brazen ring with the words, "I am the fish which was first put in this lake by the Governor of the Universe, Frederick II., the fifth of October, 1230."

I once saw a masq'allonge that measured a mere trifle in excess of four feet in length, that was mounted, said to have weighed eighty-one pounds, and to have come from the St. Lawrence in the vicinity of Alexandria Bay; but a larger fish to all appearances, taken from Traverse Bay, Michigan, weighed but forty-seven pounds. Mr. Frederick Alvond declares, in Goode's "History of Aquatic Animals," that he took one in Maumee Bay, Lake Erie, that weighed eighty-five pounds; and in the same volume Mr. Kumelein, of the U. S. Ichthyological Commission, asserts his belief that one Mr. Schultz took one fifteen pounds heavier from the waters of the "old harbor," Milwaukee, Wisconsin. Likewise, an unknown correspondent of the *American Field* (vol. 26), under the *nom de plume* of "Piscator," solemnly announced the capture of a fish of 101½ lb. from Lake Germain, Wisconsin.

Large or small, neither the masq'allonge or other form of pike is easy of capture, or a comfortable customer to manage when once hooked. It is not that he is *game* in the true sense of the word, but that he is strong, vicious, wicked, all of which is doubly enhanced by rage and fear. His long lank body marked with green and black, or plumbeous and darker lead, his pointed head, sinister eyes, and jaws bristling with sharp, keen teeth, the canines an inch or more in length perhaps, give to him an aspect of true devilishness, and are indications of what he might do if he dared and opportunity offered. I would earnestly recommend his captor to keep hands away from his jaws, unless desirous of parting with one or more digits, or having the member mangled in a way to put to shame a patent sausage machine; besides, once fastened, he hangs on with the strength and tenacity of a bull-dog.

I cannot regard pike fishing as constituting in any measure a true sport, since it usually demands little more than brute strength and sound tackle. Still any and all of the species will fight when cornered, and that, too, with all the fierceness and wickedness of an inherent malevolent disposition; and his supple, lizard-like form is capable of almost unheard-of twistings and contortions, as now on back, then on belly, he dives with the velocity of light to the bottom of the pool, appearing in midair an instant later, perhaps, dashing the water in showers from his glistening sides. More often, however, he sulks in the depths of the pool, or dashes hither and thither in blind impotent rage that merely lashes the water into feathery spumy foam. His most brilliant repertoire is an endeavor to entangle the line among roots and rushes, or beneath rocks, bowlders, and sunken logs, whereby continual chafing or the impatience of the angler may yield him freedom, for in his long, lank head lurks a brain not altogether devoid of fertility and cunning. That he is far from a sufferer may be judged by his reptilian characteristics; moreover, is evidenced in many other ways. It is fear

rather than pain that goads him to madness. Consequently, he will bear double the punishment of either salmon or trout. When impaled upon the spear, he breaks his teeth in vicious spite upon the iron shank, or sinking them deep in, in the wooden handle, endeavors to make thereof a fulcrum whereby he may twist himself off the barbs; and if successful, regardless of wounds, perhaps with lungs and intestines protruding and trailing, he dashes away in precipitate, ignominious flight. And good reason, too, he has to seek a place of safety, for the cannibal instinct is strongly implanted in all the race, and should his wounds be discovered, or his trail be ensanguined sufficiently to permit of scenting and following, his many relatives, great and small, seek him out, and rend and tear piecemeal with fiendish ferocity and glee, satiating appetite like so many wolves, to the very last minute morsel. Even parents destroy their own tender offspring when opportunity offers; and yet they can hardly be deemed parents, since they have no part in care or rearing, beyond the mere fertilizing and deposition of the ova.

Mr. Irving Beeman, one of the most enthusiastic admirers of *Esox nobilior*, insists he can swim faster, turn quicker and shorter, pull harder, and jump higher than any known fish. "On one occasion," says he, "while out rowing with a boy of fourteen, I had the happiness to hook a very large masq'allonge, which at once made for a shallow mud flat, where we both grounded. I expected to lose him; but while working with desperate ingenuity to bring him to basket, the boy attempted a flank movement by wading, and succeeded in getting the gaff through the fish's nose. Then began the most amusing squabble it has ever been my lot to witness, it being another version of 'pull devil, pull baker;' and for a time it was a matter of grave doubt who would win—the boy or the fish; and had the latter exerted himself and made for deep water, there was no reason why he might not have bagged the former for his dinner.

"The struggle at last ended in favor of the boy, as the monster was suffocated by the cloud of mud stirred up in the contest, and I had the satisfaction of lifting him into the boat, when I was no longer surprised at the fight he made, as he measured two inches more than five feet, and turned the scales gently at forty pounds."

Strong, heavy tackle is required for pike fishing, since the plebeian robber may be had in all sizes, in the same pool, and there is no knowing when a "big one" may be lured to hook. Heavy, oiled linen, close braided, is a good line, but gimp and gut snells and leaders are useless; neither are spoons and other bright lines of any special value or advantage. Three or four bent hooks on to a yard of copper wire, or, better yet, on steel piano string, and baited with live minnows, chubs, dace, dog fish (*amia*), or frogs, will insure success. Chicken offal is very taking bait, in spite of the manifest preference for live food, and often proves irresistible when the latter fails. The fancy gear of shops is rarely of use, and commonly most misleading as to strength, while a cheap linen or hempen line that has been fairly tested, with a stout bit of wire, and a Limerick hook, on which is impaled a live mouse or a little "pickerel" frog, will tempt and hold the most elephantine of the long-nosed species.

Spearing by daylight or torchlight is, perhaps, the most efficacious means of capture, if one is expert in wielding the tines and the fish can be found. But, then, pike are not often caught napping at any time during the twenty-four hours, are very finical in their appreciation of the attractions of artificial light, and one who secures a single fish after twelve hours' watching may consider himself well rewarded for his toil. Further, the fish possess certain eccentricities peculiar to themselves, and have a knack of dodging the barbs at the very last moment, just as they are apparently about to enter the flesh, and that, too, by a movement that, in celerity, rivals the proverbial lightning flash, resembling more nearly the diving of a loon before the gun.

Shooting is sometimes resorted to, and has its devotees, but is not available save in the spring, during high water and the spawning season, when the fish are far from fit for the table. During the warm days of late April, or in May, especially after depositing ova, pike love to lie for hours, if undisturbed, along the surface of the water, basking in the sun. To send a rifle bullet or contents of a shot cartridge home, demands even more patience and skill than spearing, for not only are long waits in almost complete immobility demanded, but it is very difficult to hit so uncertain a mark as the back of a fish, handicapped, as one must be, by the reflection and the difficulty of calculating distance over water. Again, a dead fish is by no means a fish bagged, and wading or swimming may be necessary, or the carcass, before it can be secured, may serve to feed the appetites of a score of others of his kind. Finally, one shot is sufficient to frighten all others away for hours, or at least prevent basking, which latter is essential to success.

Though pike are esteemed excellent food fish, personal experience does not coincide with the popular verdict. If they possess any merit for the table, it is solely due to the abilities and exertions of the cook. That masq'allonge, with little effort, may be dished up in most palatable and tempting style may be admitted, but with as little trouble so could be served an old rubber shoe, to employ a simile of Frank Forester's. Herbert, however, extols pike, for which I have an inherent aversion.

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DISEASES OF FRUIT.

THE number of diseased conditions of fruit due to reproductive parasites is so great that we must content ourselves with reference to a few of the more interesting. They are caused by many very diverse fungi, even the heteroecismal Uredineæ play the part of reproductive parasites.

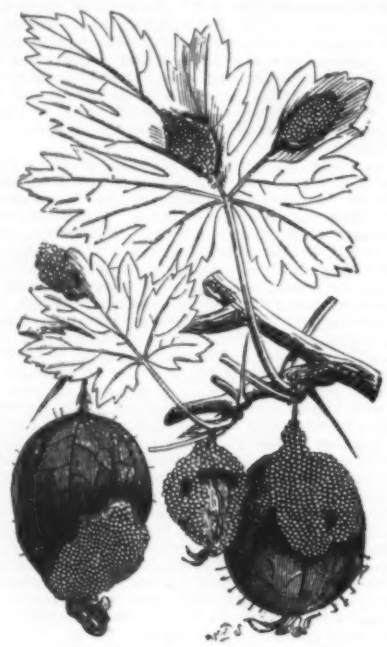
ÆCIDIUM BERBERIDIS, ETC.

Puccinia graminis frequently forms its æcidiospores on the fruit of the common barberry, but this site is almost invariably selected by the fungus when it occurs on the common mahonia. Probably this is due in some measure to the thickness of the cuticle of the evergreen leaves affording an obstacle to the entrance of the germ tubes. The æcidiospores, which are preceded by an abundant development of the so-called spermatia, occur on the outside of the berries, which become distorted by their presence, as the portion invaded by the spawn is unable to expand like the healthy parts of the berry. The affected mahonia berries will not germinate.

Another heterœcious Uredine often forms its æcidiospores on the fruit of the garden gooseberry and another upon the berries of the wild black currant; in both cases the affected fruit does not ripen, and behaves in a very similar way to the mahonia berries.

On the fruit of the hawthorn the æcidiospore of a gymnosporangium is sometimes found. It causes an extensive hypertrophy of the fruit, whose reproductive functions it abolishes, and so alters it in appearance that one would hardly think the brown shaggy body thus produced could be fruit of this well known plant. These fungi are probably conveyed to the flowers by insects; they afford an interesting object for study, as it is possible such investigations might throw some light on the function of those organs to which the name spermogonia has been applied, and which are known to be visited by insects on account of the secreted sugar they exude.

The fruits of the apple and pear are very subject to a variety of diseases familiar to all of us, which cause black, dry, more or less circular patches on the exterior. To such an extent does this sometimes occur that the fruit is quite spoiled, the presence of the mycelium rendering the affected part of the fruit hard, woody and tasteless. When many points are attacked, the hardening is so great as to quite prevent the expansion of the fruit, so that it does not ripen. The infection takes place very early in the year, almost as soon as the tree has blossomed, if not before. So great a pest has this become in the great fruit-growing districts of America, that the State botanists have tried various means for its prevention, the most successful of which



DISEASE OF GOOSEBERRIES.

seems to be spraying the tree early in the year with Bordeaux mixture.

PEZIZA PSEUDO-TUBEROSA.

Even the fruit of the oak is liable to be attacked and its functions destroyed by a reproductive parasite. The peziza pseudo-tuberosa of Rehm is a pretty little cup-shaped fungus, of a brown color, about half an inch in diameter, supported on a rather long flexuous stem. The interior of the cup is rather paler in color than the exterior; the base of the stem grows out from the remains of the interior (cotyledons) of the acorn, which have been altered by the mycelium into sclerotium-like bodies. The perfect fungus is formed in spring upon acorns which have lain on the ground during the winter, and which, instead of germinating, bear the fungus. The details of its life-history are at present unknown, but it is probable that they are not unlike in some points those of the species about to be described on the fruit of vaccinium. Two other pezizas, one on the catkins of the willow and another on those of the poplar (Peziza amentacea and Peziza caucus), may also here be alluded to.

THE CRANBERRY DISEASE.

From the recent careful study of Woronin, we have learned the full life-history of certain pezizas which occur upon the dead fruit of the various cranberries; the species are four in number:

Sclerotinia vaccinii,	on Vaccinium vitis idœa,		
" oxycocci,	"	oxycoccus,	
" megalospora,	"	uliginosus,	
" baccarum,	"	myrtillus.	

Sclerotinia vaccinii is a small brown peziza found in spring upon a sclerotium formed from the fruit of Vaccinium vitis idœa by the action of the mycelium of this fungus.

The octosporus asci discharge their sporidia into the air; these, when they alight upon a young green leaf of the host-plant, send out a germ-tube, which penetrates the epidermis of the leaf, and produces a mycelium in its tissues, the presence of the parasite being manifested by a change in color it produces, and by the development of myriads of moniliform gonidia. These gonidia were found by Woronin to germinate rather differently in various media, such as pure water, rain water, plum juice, etc. In the natural course of events, however, they are either carried by the wind, or, more frequently, by insects, to the stigmata of the vaccinium upon which they germinate, and emit a germ-tube, which passes with the pollen tubes to the ovary. In the ovarian tissues it gives rise to a mycelium, which mummifies the fruit, and converts it into a sclerotium, that lies dormant during the winter months, and in spring develops the peziza.—*C. B. P., in the Gardeners' Chronicle.*

GRAFTING ON GRAPE VINES.

IN the present article we will not touch upon the subject of grafting by approach, but will confine ourselves to cleft grafting and the other methods illustrated in the accompanying cuts, for which we are indebted to our contemporary, *Der Stein der Weisen*.

Grafting by a Simple Side Cleft.—The earth is cleared away from the foot of the vine stem to the point where the side roots start, and then the stem is cut off horizontally a little above this point, and split from the circumference to the center with a grafting knife which must be strong enough to stand blows from a hammer. The split can be made deeper by using the tool as shown in Fig. 1. The scion or shoot, which must be long enough to leave at least one eye above ground, is sloped off for an inch or two, in the form of a flat wedge (Fig. 2), and as it must fit in the split or cleft, which is narrower at the center than at the circumference of the stock, the side of the scion that is to enter the cleft should be thinner than the outer side (Fig. 3), the close contact of the outer edges being of importance. Section A, Fig. 4, shows what should be avoided, and section B, Fig. 5, the result for which the grafter should strive.

In order that the scion may be introduced into the split, the latter is held open either by the end of the knife—which is inclined to one side—or, better still, by a little wedge of hard wood, C (Fig. 6), which is withdrawn as soon as the scion is well in place. With a cleft of this kind, that does not run diagonally in the stock, it is seldom necessary to bind the parts together, the scion being held firmly enough by the natural closing of the wood. The cut surface of both the cleft and the scion must always, however, be carefully coated with grafting wax before the hole in the ground is filled with earth, which should, at first, be carefully heaped around the grafted portion.

Grafting by a Simple Transverse Cut.—If the stock is thick enough, as it generally is, and it is desired to use two scions, the cleft is lengthened until it extends the entire width of the stock, and then a scion is placed at each end of the split, which can be more easily kept open than a side cut. These scions must be so cut (Fig. 7) that the tongues on the two sides will be of equal thickness, and then the width of the split which receives them will be the same throughout its length. It is very easy to tell by taking hold of the scions whether they are held firmly in place or need to be bound in.

Grafting in a simple transverse cut is much used for small stocks that are of about the same size as the scions. In this case the latter is so easily introduced and held that all surfaces which are brought in contact adhere perfectly and the cut edges of the bark on the two parts coincide (Fig. 8). If the thickness of the stock is equal to the thickness of two shoots, they can be placed as shown in Fig. 9.

In all cases where rooted stocks in a vineyard are operated on at a certain distance below the surface of the ground, and it is desired to have the shoot take root, it is better to split the scion rather than the stock. This process is called saddle grafting. But if the grafting is done before planting, and the independent rooting of the scion is not desired, cleft-grating will answer the purpose. In all cases it is well to slope off the stock on both sides of the cut, as at B in Fig. 10. If besides the transverse cut already described a second one is made perpendicular to the first one, there will be room for four scions. Our previous remarks in regard to binding will apply in all these cases.

There may be several good and bad reasons for not wishing to split the stock through the middle, of which we will mention a few, viz., if the pith is touched, the stock will die; the objection of some people to making cross-shaped cuts; the desire to graft with six scions instead of four, etc. In such cases, two or three cuts are made in the direction of chords, and a scion is placed in each end of these cuts, each scion being sloped so as to fit well, and then a band should, generally, be put around the whole.

Cleft Grafting with a Scion that is to be Rooted.—Instead of cutting the scion to a point and pushing it downward in the cut, so that its outer surface shall coincide with that of the stock, it is cut, in this case, so that one side can be pressed into the cut and the part below the contacting surfaces can reach into the ground, for which purpose a deeper hole is dug. In this case, also, the upper part must be long enough to leave one or two eyes above the surface of the ground. A strip of bark and wood is taken off on each side, A B (Fig. 11), as in grafting by approach, care being taken that the whole shall have a wedge-shaped cross section, C (Fig. 12), as when grafting in a side cut. Then the stock and scion are joined (Fig. 13), and, if necessary, tied together, coated with wax, and the hole in the ground filled up.

Saddle Grafting.—If Alexander Dumas had explained this, he would have said, "It is just the same, except that it is exactly opposite." It is only necessary to reverse the vines that have been grafted as described, and we will have the so-called saddle grafting. In my first experiment with roots and rooted internodes, it has been found that it is easier to cut a little stock, especially when it is rooted, to a regular wedge shape, than to split it properly. If the grafter cuts upward, toward himself, with a garden knife, he can make a nice smooth edge and two even surfaces on any stock, no matter how knotted and twisted it may be; while he is never sure, with even the straightest stock, that he can split it nicely, and often makes a very irregular cleft. If an upwardly opening split is made, it may easily happen that earth or sand will fall into it, or, what is much worse, that water, that arch enemy to all grafting, will get in, while the split scion acts, not only as a saddle, but also as an umbrella.

As to the splitting of the scions, they are always young wood with straight internodes, and can be held in the hand as desired, so that nothing is easier than to

Fig. 1

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

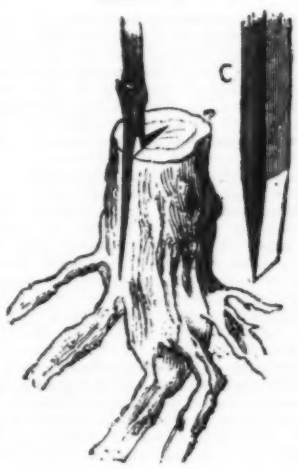


Fig. 7.

Fig. 8.

Fig. 9

Fig. 10.

Fig. 11.

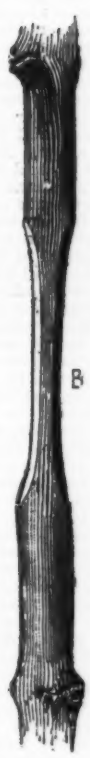


Fig. 12.

Fig. 13

Fig. 14.

Fig. 15.

Fig. 16.

Fig. 17.

Fig. 18.

GRAFTING GRAPE VINES.

make a straight and clean cut that will fit exactly on the wedge-shaped stock, bringing all the adjacent surfaces into that close contact which assures their growing together. These methods of grafting are so simple that Figs. 14 and 15 seem almost superfluous. The former illustrates a case where the stock and scion are of the same thickness, while in the second case the stock is thick enough to carry two saddles. I need only add that as the special object of this method of grafting is to facilitate the rooting of the scion, the knots and eyes, T T, must be left on the ends, said knots being the parts that form the roots.

Grafting in a Side Groove.—In all the methods of cleft grafting above described, we have confined ourselves to simply splitting the wood without removing any of the substance; but there are other methods suggested by the praiseworthy desire to save the subject. In following out these methods angular cuts or grooves of exactly the same dimensions as the designs are formed, instead of making clefts, which always weaken the stocks, and parts of which are always useless. Much attention has been paid to the invention of tools by means of which the scion and the cut can be made, mechanically, to fit perfectly. Figs. 16, 17 and 18 show a right-angled cut, an acute-angled cut, and a groove, and give an idea of the proper forms for the scions which they are to receive. It will be understood that for this kind of grafting, as in the other methods described, the scion can be rooted, as shown in Fig. 18.

OSMOSIS, AND ITS RELATION TO PLANT LIFE.

By H. GARNETT.

THIS was the subject of a paper read at a recent meeting of the Chemists' Assistants' Association, London. The author first described the difference between the process of the diffusion of a strong solution of a salt upward into a layer of liquid superimposed which originally contained no salt until the whole becomes of equal strength and the process of dialysis. In the case of dialysis, the material of which the membrane is made greatly influences the amount and rate of diffusion or osmosis. If a glass cylinder be closed at the lower end with a securely tied piece of bladder or vegetable parchment, and a solution of a diffusible salt be poured into the cylinder, the whole then being placed in water so that the level of the two liquids is the same, in a short time the liquid inside the tube will rise; and if the cylinder is quite full, and securely attached to a manometer, the latter will indicate a certain amount of pressure. If, however, the water outside the cylinder is tested, it will be found that a certain quantity of the salt has passed through the membrane, which evidently exercises a certain but limited resistance to the outward passage of the solution. Certain artificially prepared membranes form much more perfect osmotic septa, and can be used for measuring exactly the osmotic pressure of any substance. They may be composed of precipitated ferric hydrate, cupric ferrocyanide, silica, or tannate of gelatine. When one of these substances is employed, an osmotic cell may be prepared in the following manner: A porous earthenware cell is first washed with dilute hydrochloric acid, then with dilute potash, and finally with water. Placed in boiled water, the cell is then exhausted by means of an air pump until no more bubbles of air are given off. The cell thus saturated with water is transferred to a 3 per cent. solution of cupric sulphate, and allowed to remain for several hours. The solution is then poured out, and after the interior has been washed with water and dried with absorbent paper, the cell is allowed to stand a few hours, until perfectly dry. It is then filled with a 3 per cent. potassium ferrocyanide solution, and set in copper solution to the required height; after twelve hours the cell is complete, and after rinsing out with water may be filled with the particular solution under observation. Such a membrane as is thus formed is found to be peactically impervious to most dissolved substances, while it allows water to pass readily; so that if a solution, for instance, of sugar is filtered through under great pressure, only pure water passes through the membrane. Considerable difficulty is found in making a joint with tube leading to the manometer which will withstand the great pressure which in course of time is set up.

Many measurements have been made by Pfeffer, Van t'Hoff, and others, of the osmotic pressure of solutions. That, for instance, of a 1 per cent. solution of potassium nitrate has been found to equal three atmospheres. A salt in solution behaves, in many respects, like a gas, its pressure varying with the temperature in accordance with Charles' law, and is the same as that which it would exercise if the substance were in the gaseous state and occupied the same volume as it does in solution. It obeys Boyle's law, the pressure being proportional to the molecular weight of the salt in solution.

The cell wall, the lining of protoplasm, and the cell sap constitute the essential parts of the living cell. The cell wall consists of cellulose, which is highly elastic and non-porous, yet readily permeable by liquids, at the same time possessing a very important power of imbibition or swelling up with water. This swelling, however, is not comparable with that of a sponge, for in cellulose there are no cavities or capillary passages; but, according to Naegeli, cellulose is composed of minute particles named micellæ, which exert a strong attraction for water, so that each particle is separated from its neighbors by a film of liquid, and this is, perhaps, comparable with the manner in which the water of crystallization is held in a crystal. The cell wall, in all probability, is not capable of acting as an osmotic membrane, or only to a slight extent, for it readily permits of the passage of dissolved substances.

The protoplasm, which almost entirely fills the cavity of a newly formed cell, is usually found after its growth to occupy the position of a lining of plastic matter inside the cell wall, and often closely applied to it. The cell now presents many analogies to the porous earthenware cell with its membrane of cupric ferrocyanide; there are, however, important differences. Owing to its power of imbibition, the cell wall takes up and passes on water or solutions of salts from cell to cell, and does not oppose any marked resistance to the filtration of dissolved substances. It, however, plays an important part in consequence of its elasticity. The lining of protoplasm is the real osmotic membrane of the cell, offering most marked resistance to the passage through it of substances in solution, but not to the same extent as the artificial membrane. It appears, in addition, to be able to exercise a certain selective power, deciding which substance shall or which shall not pass, its osmotic action toward a substance appearing to vary under different conditions. This protoplasmic layer is not possessed of much rigidity, and is not able to support a great amount of pressure; and here, consequently, is the importance of the elastic but firm cellulose wall giving it support. Thus, assuming that the vegetable cell is capable of allowing osmosis to take place, and of exhibiting and sustaining a certain amount of osmotic pressure, the important bearings that osmosis has on the life of the plant can be considered.

In plants possessing a pho-vascular structure, practically all the necessary water, and, consequently, all the nutrient materials which are taken up in a state of solution, are absorbed by the roots through the root hairs. These root hairs apply themselves very closely to the particles of soil charged with water containing in solution the various salts. Of these solutions the very dilute (1 or 2 per cent.) prove the most beneficial. Many of the more important plant constituents exist as soluble salts—for example, nitrates of the alkalies and calcium, soluble phosphates, and ammonium salts, as chlorides and sulphates—and comprise most of the essential elements required, which are phosphorus, sulphur, chlorine, iron, potassium, sodium, calcium, and magnesium. Hydrogen and oxygen are taken up as water. Carbon is probably never taken up by the roots, but is assimilated by the leaves, the chlorophyl, under the influence of sunlight, breaking down the carbon dioxide of the atmosphere, fixing the carbon, and liberating the oxygen. Until recently it was considered that the nitrogen of the atmosphere was not utilized by plants, and probably the leaves and roots of plants have not the power of absorbing it directly. Recent researches, however, have shown that in certain cases (notably in the Leguminosæ) bacteria form nodules on the roots, and absorb free nitrogen, passing it on to the plants.

A constant supply of water and nutriment is essential for the well-being of the plant, for in the leaves transpiration or evaporation of water through the stomata is constantly going on. The leaves may also be considered as the laboratory of the plant where the various nutrient materials required are elaborated from the crude materials assimilated. Although for absorption all substances must be in solution, they do not necessarily so exist in the soil, and this difficulty in many instances is overcome by the plant. The root hairs almost always contain an acid sap, and being applied very closely to the solid particles in the soil, small quantities of their acid contents diffuse out through the cell wall and dissolve substances which are insoluble in water. Mr. Garnett here showed a block of marble, which had been placed in the soil underneath a germinating haricot bean, upon which could be seen the delicate marks caused by the rootlets, the calcium carbonate having been dissolved away by the acid sap. Sachs considers the acid to be carbonic, while others have thought it to be acetic. The latter or some similar vegetable acid is most probable. When plants are grown in dilute solutions of the salts required by the plants instead of soil, it is found that the salts are taken up not necessarily in the proportion in which they exist in the solution, from which arises the so-called selective power of roots.

Having found its way into the root hairs, the sap passes on by osmosis from cell to cell through the parenchyma of the root cortex, and so reaches the fibro-vascular column. The wood of these fibro-vascular bundles, it has been conclusively shown, forms the path of the ascent of the sap in the stem, but these wood cells differ from those of the parenchyma in that they do not act osmotically, although altered cellulose (lignin) permits the filtration of water. So that the sap, having reached the inner cells of the cortical layer, is driven by osmotic pressure through the wall of the wood cells and vessels.

The osmotic action of the root cells gives rise to what is known as root pressure, and this is the cause of what is termed "bleeding," when the stem is cut, which is especially noticeable in perennials in the spring, when active growth is renewed. With respect to this bleeding the first quantitative experiments were made by Hales in the year 1712, who found that the pressure exerted by the bleeding root stock of a vine equaled 38 inches of mercury. Clark, who experimented on root pressure in the case of *Betulu lenta*, found that at night the pressure ceased, and in some instances there was even suction, pressure recommencing soon after sunrise. On one occasion the pressure exerted was equal to 75 inches of mercury, or 2½ atmospheres.

This pressure, although in some cases capable of supporting a column of water 80 to 100 feet high, will not account for the rise of water in stems 200 to 300 feet in height, and in the case of annuals and non-lignified cells osmotic pressure is probably the sole important factor in the ascent. For observing the rate of ascent, besides the watering of the plants with colored solutions and noting the rise of coloring in the tissues, McNab has devised a method of watering with a dilute solution of a lithium salt, which is afterward easily recognized in the stem by means of the spectroscope. By this means the rate of ascent in cases of rapid transpiration was found to be as great as six feet per hour. The most important feature in connection with the ascent of sap is that when transpiration is most marked, and consequently the upward current the greater, a section made across the woody stem shows the vessels to be empty, pointing to the fact that the transmission of sap does not take place in the cavities, but in the lignified walls of the vessels. Naegeli, Sachs, and others have shown that this power of imbibition and transference of water by wood is an inherent property of lignified tissue, the height of the column in no way interfering with the action. When through transpiration of water from the leaves the wood of the upper part of the plant parts with some of its imbibed water, there is an immediate flow from below to supply the loss.

Besides this rapid transpiration current, there exists a transference of material from one part of the organism to another, its direction and amount varying with the needs of the plant. This action is entirely due to osmosis, and a good example of it may be seen in the storage of starch, as winter approaches, in the roots or tubers, to form a reservoir of food material from which the plant will draw a large amount of nourishment for its growth in the spring. The carbon of the carbon dioxide in the atmosphere is fixed by the action of the chlorophyl of the leaves, first appearing as starch, which is speedily transformed, probably by an enzyme, into some soluble carbohydrate. This passes through the cell wall of the parenchymatous portion of the leaf and stem, through the outer cortical portion of which it makes its way to the roots or tubers, where finally, by the action of small nuclei of active protoplasmic matter, it is changed again into insoluble starch. Among other proofs of the downward transfer of food material may be mentioned that if a ring of the cortical portion of the stem of a potato be cut away, although the growth of leaves and the transpiration of water take place as before, no starch will be found deposited in the tubers.

Another important purpose of the flow of liquid through the plant is the maintenance of a proper degree of osmotic pressure or turgidity in the cells, for probably no cell growth takes place unless the cell wall is in a tense or stretched condition. The cell grows by the addition to its substance of cellulose, which is secreted and deposited by the protoplasm, the fresh particles being either deposited between the original ones or as a layer on their surface. Mr. Garnett demonstrated by an experiment suggested by Traube how it is possible to imitate this process of cell wall building. A crystal of cupric chloride is dropped into a 2 or 3 per cent. solution of potassium ferrocyanide, when immediately a film of cupric ferrocyanide is formed round the crystal. The cupric chloride so contained absorbs water, but is unable to pass out; consequently the pressure outward soon becomes so great that the film is ruptured. The copper solution flowing out, on coming in contact with the potassium ferrocyanide solution, is again coated with a fresh film, and the cell is thus again closed. The process, although entirely different, is somewhat analogous to the formation of the wall of the vegetable cell.

NORTHERN SENEGA.

By L. E. SAYRE.

THE geographical distribution of senega has been a subject of a good deal of interest to the members of the pharmaceutical profession and the drug trade for a number of years. Chief among the contributors to our present knowledge of the drug in this particular have been Professor J. M. Maisch and Professor J. U. Lloyd, as will be seen by glancing over back numbers of the *American Journal of Pharmacy*, "The Proceedings of the American Pharmaceutical Association," and other pharmaceutical publications.

Reference has been made to senega growing in Wisconsin and Minnesota, but there has not been very definite information given, I believe, as to its collection or the exact district of country from which it is collected in these States. "Northern" Senega has been a current term meaning a variety of senega having certain physical characteristics very unlike the original Polygala senega. Professor Lloyd ("Proc. Amer. Phar. Asso.," 1881), describing this variety—which he says is derived from the Northwest, from the States of Wisconsin and Minnesota—says it is very large and fleshy, sometimes white, again rather dark brown, the knotty crown measuring often from two to three inches in diameter, even of the dried plant. The root just below the knotty head is (when dry) from the size of the little finger to that of the thumb of a man, six to ten inches in length, and generally destitute of keel; not so contorted and branched as the "Southern" senega.

L. L. Dyche, Professor of Zoology and Taxidermy of the University of Kansas, some months ago made an extensive hunting tour in the Northwest, the main point of his operations being in that country lying near the Lake of the Woods. During this hunting expedition he had an excellent opportunity of studying the country, its products, and its people. On his return he handed me a root which he thought might be of some interest to me He said it was collected in very large quantities and seemed to be one of the staples of that country. The natives depending upon its collection as one of the means of subsistence have made this quite an industry among them. There the squaws and the children dig the root, while the "braves" hunt the valuable fur-producing animals. Professor Dyche says that he saw at the different trading posts in Marshall and Kittson Counties, in the storehouses, as much as a thousand pounds stacked up in one heap. At a little town, Rocksted, near Thief River Falls, the Indians come in from long tramps of forty miles or more and bring in the fur, skins, and this snake root. Here they had an immense stock on hand. Since his return, Professor Dyche has received a letter from a trader at Jadis, Kittson County, stating that he has on hand a thousand pounds bagged up, waiting for a fair market price.

The root referred to is undoubtedly a good sample of senega. In length it varies from 4 to 8 inches; in diameter from 1-16 to ⅛ inch. Surrounding the root is a dark scar-covered head, having a diameter of from ¼ to ½ inch. This head in the case of younger roots is covered with immature pinkish leaf-covered stems. The characteristic keel of Southern senega is rarely present, and the contour of the root is much less contorted. The color ranges from the light yellow of young roots to the dark brown of the older ones.

Near the head, prominent annulations are present. These continue with enlarging intervals of space for some distance down the root. Lengthwise the whole root is deeply wrinkled, while frequent warty enlargements occur. The branches are not numerous. In considerable quantities the odor of gaultheria is quite prominent, as it is also in a cold aqueous infusion. The taste is very acrid.

Under the microscope the wood is found to be cylindrical, and the ingrowth of the inner bark on one side which produces the keel of the Southern variety is not apparent in a majority of cases. The wood is whitish, ligneous, and occupies about ⅓ of the diameter of the root.

A sample of the drug was handed to Mr. McClung, one of the senior students, for the estimation of the polygalic acid. He used Quevenne's process, and obtained of the pure acid 3·5 per cent. Methyl salicylate was abundant, as shown by the ferric chloride test.

It would seem from the above that this specimen handed to me by Professor Dyche represented a good sample of senega; its quality equal to the average root of the market.

I have planted some of the roots, which seem to be full of vigor, and hope to be able at some future time to classify the plant.—*Am. Jour. of Phar.*

A NEW INSTRUMENT FOR QUICKLY DETERMINING REFRACTIVE ERRORS OF THE EYE.

By ELMER STARR, M.D., Buffalo, N. Y., Lecturer on Ophthalmology in the Medical Department of the University of Buffalo.

THE refraction of an optically perfect eye is such that parallel rays of light entering it are brought to a focus on its retina. Any deviation from this condition constitutes an error of refraction, and requires for its correction some variation of the luminous rays from parallelism.

The generally adopted method of determining the refraction of the eye is to use test types placed at such a distance that the rays of light emanating from them may be regarded in practice as parallel; and the deviation from parallelism necessary to correct a refractive error is effected by placing a lens in front of the eye. Besides this procedure there are many other methods of changing the course of luminous rays coming from a test object. The single convex lens is the simplest means of varying the direction of luminous rays, and has for this reason been often used in optometry.

If an object is placed at the focus of a convex lens, the rays of light coming from this object will, after passing through the lens, be parallel. The farther the object is removed from the lens, the more the rays will converge after passing through it, and in this way the deviation necessary to correct an hypermetropia may be obtained. On the other hand, if the object is brought from the focus nearer to the lens, the rays which leave the lens will be divergent; and this change is such as to adapt it to the refractive condition of a myopic eye.

Cocius, Smee, Von Graefe, Badal, and others have made use of this principle in constructing optometers, the test objects of which consist of threads or lines, or of letters and figures placed at the focus of a lens of three or four inch focus.

All these optometers have the disadvantage that

Fig. 1. When M and P are in contact, rays $a\,a'$ continue in their original direction. The effect of moving M from p to p' is shown by the broken line.

they provoke a certain effort of accommodation, inasmuch as the observer is conscious of the proximity of the test object. It is important that the accommodation be excluded in determining the static refraction of the eye; otherwise, the dynamic being added to the static refraction, the real error may be masked.

Then, too, some of these instruments do not serve to determine the visual acuteness because of the change in the size of the retinal image which they produce; the measure of visual acuteness is given by the size of the retinal image, and the acuteness of vision in one eye is comparable with that in another only when we know the size of the smallest retinal image that each can distinguish.

An optometer is fitted for the simultaneous determination of visual acuteness and refraction only on condition that the retinal images of all eyes examined by it have the same size.

The instrument here described fulfills these conditions completely, and has none of the disadvantages of the single convex lens.

The instrument consists of a cylindrical tube about 15 ctm. long, mounted on a stand, which admits of its being regulated for height and inclination. Within the tube a 16 D. convex lens (P, Fig. 1) is fixed, at a point 6¼ ctm. from the proximal end; that is, at just the focal length of the lens. Beyond the convex lens, and moved by means of a rack and pinion, is a concave 16 D. lens (M, Fig. 1). The effect of this concave lens is to render parallel rays divergent, but this effect is neutralized by the convex glass when the two lenses are in contact. When, however, the two lenses are separated from each other, the convex glass more than neutralizes the divergence caused by the concave glass and the rays are made to converge. The action of the system will be better understood by reference to Fig. 1.

The eye whose refraction is to be tested is situated at the end of the tube at E. The effect of the concave lens, M, upon the parallel rays $a\,a'$ is to cause them to diverge, so that they leave the glass in a direction as if they came from the point, o, which is the focus of the lens, M, which in this case is 6¼ ctm. in front of the glass. The effect of the convex glass, P, then, upon the rays, $a\,a'$, is the same as if the rays proceeded directly from the point, o; in fact, the point, o, may be considered, in this respect, as the object. Now, as already stated, when an object is placed at the focus of a convex lens, rays of light coming from this object will, after passing through the lens, be parallel; and if the object be removed *from* the lens, the rays will *converge* after passing through it. So that if the lens, M, be brought into contact with lens, P, so that o falls in the focus of lens, P, the rays, $a\,a'$, will leave P parallel; and if the lens, M, be moved away from P so that o falls outside the focus of P, the rays, $a\,a'$, leave P *convergent*, and the amount of the convergence depends upon the distance of o from P—that is, upon the distance the lenses, M and P, are separated. Calculation shows that for every $\frac{1}{16}$ ctm. the lenses are separated the effect is the same as a one-diopter convex lens, or + 1 D.; or a separation of the glasses 6·25 ctm. is identical with a + 16 D. lens.* It will be seen, then, that every possible degree from zero or nothing up to + 16 D. can be obtained with this combination. For any concave or minus combination it is only necessary to place in the proximal end of the tube at E a minus lens of such power as to neutralize the converging rays coming from the lens, P, when M and P are 6¼ ctm. apart. That is, when the lenses stand in this position, their effect is just neutralized by a concave 16 D. lens placed in the end, E, of the instrument, and the rays of light then leave this lens parallel again and the combination once more stands at zero. If now the lenses M and P are brought nearer together, the result is a combination *weaker* than + 16 D., so that the concave lens at E more than neutralizes this effect, and the rays leave the instrument *divergent*, or as they would after passing through a single concave lens; so that by this means every possible degree from 0 up to —16 D. can be obtained.

In practice the tube of the instrument is graduated with a scale showing diopters and half-diopters, and the frame of movable lens, M, carries a pointer which indicates the number of diopters corresponding to the amount of separation of the glasses. A disk having a stenopaic slit and fitting into the end of the tube serves to determine the refraction of each meridian of the eye separately.

The advantages of this combination are decided, as it allows of the use of the ordinary test type placed at the usual distance, so that no effort of accommodation is caused by the proximity of the test object. Then, by this arrangement, the anterior focus of the eye is kept at the focus of the convex lens of the instrument, so that no enlargement of the test object is produced. In other words, the conditions are most favorable for determining the actual refraction of the eye.—*N. Y. Med. Jour.*

* The formula for determining the effect of a given separation of the lenses in this instrument becomes the same as the formula for determining the point at which the image made by a convex lens falls when the distance of the object from the lens is given. For the focus of the *concave* lens is virtually the object, and its distance from the *convex* lens manifestly depends upon the distance the lenses are apart.

Let f denote the focal length of the convex lens P; d, the distance of the object (focus of concave lens) from P; and x the focal length of the resulting combination.

Then the equation $\frac{d-f}{f} = \frac{f}{x-f}$ will give the value of any given movement of the concave lens, M.

Suppose the lens, M, be moved away from P 0·25 ctm.; then the distance of object is 0·25 ctm. + 6·25 ctm. (focus of M); or d = 6·50 ctm. Focus of P = 6·25 ctm., or f = 6·25 ctm.

Substituting these values in the equation, we have

$$\frac{6{\cdot}50-6{\cdot}25}{6{\cdot}25} = \frac{6{\cdot}25}{x-6{\cdot}25} \text{ whence } x = 162{\cdot}50.$$

That is, the focus of such a combination falls 162·50 ctm. behind the lens, P. But the lens, P, is placed 6·25 ctm. in front of the eyehole of the tube; hence the focus falls 162·50 ctm.—6·25 ctm. = 156·25 ctm. behind the eye. A glass of 156·25 ctm. focus is $\frac{1}{156{\cdot}25}$ of a diopter, or 0·64 D. Therefore separating P and M 0·25 ctm. equals + 0·64 D. From this it is easily calculated that the effect of moving M 6¼ ctm. away from P is equal to a + 16 D. lens.

THE MONGOLIAN EYE.

IN the *Boston Medical and Surgical Journal* of March 3, 1892, is an abstract of a paper by a Japanese medical man published in the *Sei-I-Kwai Medical Journal* of December 26, 1891. This observer has studied in detail the differences between the characteristic eye of the Mongolian nations and of the Caucasian race. The difference between the two is caused neither by the size of the eyeball nor the color of the iris, which is the same in both, but results from the shape of the eyelids. The epicanthus, a fold of the skin covering the inner canthus, is rare in adult white persons, but exists physiologically among the Japanese, so that it is sometimes called the Mongolian fold. In the majority of cases this fold runs obliquely inward and downward from the upper lid, so that the inner canthus is not round, as in white people, but sharp. When the fold is large it spreads to the inner part of the lower lid, in which case the upper lid does not cross the cornea horizontally, but obliquely, giving the peculiar expression to the eye often met with in Japanese. Another peculiarity of the upper lid in Mongolians is the lack of development of the orbital furrow, the groove below the eyebrows. The skin covering the upper lid is very loose, so that when the cartilage is raised the skin is thrown into a transverse fold. When this fold is well developed it droops slightly over the margin of the lid. This interferes with the eyelashes, directing them downward instead of forward. In Japanese the cilia are short and straight. On the lower lid they are sometimes so badly developed and so few in number that they appear at first to be absent. When well developed they are sometimes bent inward by the peculiar formation of the upper lid, and may seriously irritate the cornea. Except for this there is no great difference in the lower lid of Mongolians and Europeans. The margin is generally more curved in white people, so that there is often a portion of the sclerotic exposed between the lid and the cornea, a peculiarity, the author remarks, which makes "their eyes looking apparently upward generally." As the skin of the lid is less firmly connected to the subjacent tissues in the Japanese, entropion is more common, but ectropion less common, among them than among Europeans.

FILARIASIS.

"AMONG twenty-six officers and colonial officers admitted to the Val-de-Grace Hospital between May 1, 1890, and February 1, 1891," says the *Lancet*, "Professor Moty observed four cases of the above disease, and two other cases in the parents or friends of the patients. Four, however, of those admitted to the hospital had been abroad for so short a time that they may be left out of the calculation, leaving six cases among twenty-two persons who had spent a considerable time in the colonies. In spite of its frequency, this disease does not appear to be generally recognized abroad, as in none of the above cases had it been diagnosticated. It was only upon undertaking an operation for the radical cure of a supposed hernia that the tumor was found to consist of dilated lymphatics. Professor Moty came to the following conclusions: That filariasis is an aseptic parasitic disease due to the presence of the filaria sanguinis hominis; that it is of frequent occurrence in the French colonies, and has been recently met with in New Caledonia. It most often appears as an enlargement of the glands and lymphatics of the groin and spermatic cord, due to the irritation of the filaria and its embryos. It can be recognized by such symptoms as chyluria, hæmaturia, etc.; but the diagnosis in each case should be confirmed by the detection of the embryos in the blood. Neither internal nor palliative treatment is of the slightest use. Excision or amputation is necessary in severe cases, and is attended with the happiest results, the removal of the hypertrophied tissue causing the adult filaria to disappear."

THE FORMATION OF DEXTRINE.*

By M. R. PETIT.

THE process recommended by Payen for the manufacture of dextrine consists in heating to a temperature of 100° to 140° starch moistened with a small quantity of nitric acid. The dextrine thus obtained is either white or slightly colored and it almost always has some reducing action upon Fehling's solution. The author has examined the influence of different proportions of acid and that of the time of heating on the character of the product. In this examination he adopted the following data, based upon trials with a known mixture of starch, non-reducing dextrine, and glucose.

1. By digesting this mixture with water at from 40° to 50° C. for half an hour the glucose and dextrine are completely dissolved and the starch can be collected by filtration.

2. The rotatory power of the solution corresponds exactly with the sum of those of the glucose and of the dextrine.

3. If the solution is fermented after having added ammonium phosphate and potassium sulphate, the loss of rotatory power indicates exactly the amount of glucose introduced and the fermented liquid no longer acts upon Fehling's solution.

The dextrine obtained by heating for an hour at 125° C. still contained a minute quantity of starch. This amount becomes inappreciable when the nitric acid used amounts to 0·8 and 2 per cent. The following table shows the reducing power indicating the amount of material capable of reducing Fehling's solution when expressed as glucose for 100 of dextrine.

Percentage of acid.	Time of heating. 1 h.	2 h.	3 h.	4 h.	Starch unaltered for 1 gramme dextrine.
0·2	3·9	5·06	3·6	2·8	0·003
0·3	7·2	5·3	3·6	3·0	0·002
0·5	7·3	6·07	4·2	3·1	0·001
0·8	8·06	6·3	4·5	4·0	traces
2·0	9·5	7·1	5·4	4·5	traces

These results show that—

1. For a given amount of acid the reducing power decreases sensibly as the time of heating is increased.

2. For a given time of heating the reducing power is increased when the amount of acid is increased.

The rotatory power of the solutions presented analogous variations, but less marked.

Other trials between 100° and 140° showed that for a given amount of acid the decrease of the reducing power was more rapid as the temperature was higher, and that the reducing power was increased more rapidly for a given amount of acid and a given time of heating when the temperature was highest. These observations explain the fact that certain kinds of dextrine have scarcely any reducing power, very long continued heat, extending to 60 or 70 hours, being applied in the manufacture, and thus the reducing power is almost entirely destroyed. The author's experiments also show that dextrine prepared by Payen's method contains in addition to glucose a substance capable of reducing Fehling's solution and incapable of fermentation. It is considered that this may be of a nature analogous to the galletine of Scheibler and Mittelmeier, but some evidence has been observed of the existence of a compound resulting from oxidation of the starch by nitric acid and having the properties of an aldehyde.

* *Comptes Rendus*, cxiv., 70.

MANUFACTURE OF OXYGEN FROM AIR.

DR. FANTA, the inventor of the process, recently explained the process and plant before the Society of Chemical Industry, Manchester. This was done by the aid of large drawings, and excellently constructed model apparatus, by which Dr. Fanta made some oxygen by his process. The chemical principles in the process are somewhat similar to the *Tessie du Motay* process, but there is a difference in the preparation of the compound with which the apparatus is charged.

The materials used are manganate of soda, and a little caustic soda, over which steam and air are alternately passed. When the steam passing through the retorts is no longer evolving oxygen, it passes over through the oxygen delivery pipe, and operates a valve which closes the passage to the holder. Again, the water from this condensed steam operates a simple piece of mechanism which opens and shuts the air and steam valves, so that the whole plant is automatic.

The reaction for the *Tessie du Motay* process the inventor gave as follows:

$$(1)\quad MnO_4 + 2NaHO + O = Na_2MnO_4 + H_2O.$$
$$(2)\quad Na_2MnO_4 + H_2O = 2NaHO + MnO_2 + O.$$

In this process, however, the steam passing first had a definite reaction which was at present only explained theoretically, though its action was undoubtedly established.

$$(1)\quad 10Na_2MnO_4 + NaHO + 10H_2O = 21NaHO + 5Mn_2O_3 + O_{15}.$$

$$(2)\quad 21NaHO + 5Mn_2O_3 + 15(N_4 + 0air) = 10Na_2MnO_4 + NaHO + 10H_2O + 60N.$$

While the experiment was being conducted, Mr. Watson Smith explained that the experiment being performed had been made in his laboratory a few days before in a precisely similar manner, and as he had bought the chemicals and prepared the manganate of soda in accordance with the inventor's directions, he could speak to the experiment being a *bona fide* one.

The contents of the retorts lasted for a very long time, virtually for years, and when found to have deteriorated could be easily resuscitated.

Dr. Bowman pointed out the advantage which would accrue from obtaining cheap oxygen, and they could make it, he said, at from 1s. 2d. to 2s. per 1,000 cubic ft., while the plant was much cheaper than that required to work the existing processes. Moreover, a temperature of about 600° F. was sufficient to evolve the oxygen, and therefore there was very little wear and tear to the plant. The gas they had obtained had been found by experiment to contain 95 per cent. of oxygen.

The whole plant and process was a typical instance of what may be achieved by chemical engineering in its strictest and legitimate sense. Mr. J. C. Bell also read a paper by Mr. S. Rothwell, while the preparation of the oxygen gas was being carried on.

ANALYSIS OF SNOW.

THE results of some analyses of snow made by Mr. J. Carter Bell, of Manchester, are as follows.

The results are expressed in parts per 100,000.

	Free NH_3	Alb. NH_3	Cl	SO_3
Corporation Street.....	0·095	0·1	7·6	0·34
Exchange Station.....	0·15	0·075	10·8	0·37
Broughton Bridge.....	0·26	0·12	9·5	0·26
Broughton Park	0·02	0·1	0·7	0·29
Sewage Works.....	0·05	0·15	0·8	0·49
Garden-on-Cliff	0·06	0·1	0·7	0·33
Kersal Moor.....	0·03	0·1	0·5	0·29
Owens College.....	0·02	0·14	1·7	0·47
Outside a chemical works. . .	0·01	0·05	0·8	0·18
Crumpsall Workhouse..... ...	0·037	0·1	0·6	0·32

It will be seen from these results that the atmosphere surrounding chemical works does not contaminate falling snow to the extent that the amosphere charged with the products of household chimneys does. The chemical works in question were supposed to emit vapors of an offensive nature, since they were the works of Messrs. Levinstein & Co., these results being part of the evidence prepared for the defendants in the prosecution of this firm at the last assize.

GASES UNDER PRESSURE.

AT a recent meeting of the Manchester Society of Chemical Industry, Mr. Heys read a paper by Mr. F. Budenburg and himself, on "Gaseous Fluids under Pressure."

The authors said that an investigation of recent explosions revealed much that could be foreseen, and also many things which were unaccountable.

Passing over such sources of explosion as those arising from bad material employed in the construction of the reservoirs and their fittings, which can, of course, be remedied, and denouncing the fatal policy of users preferring what is cheap to what is good, the authors passed on to the consideration of those accidents arising from the use of that necessary adjunct to a compressed gas reservoir, the pressure gauge. Owing to the enormous pressures at which gases are now stored, the gas enters the gauge with terrific force immediately the valve is opened, even with the smallest hole it is possible to drill. The air contained in the gauge and fittings is thus instantaneously compressed, and a great amount of heat is generated, which, combined with the frictional heat caused by the passage of the gas, is sufficient even at a pressure of eight atmospheres to reduce chips of wood to ashes, a fact which was successfully shown by an experiment.

Several simple precautions were indicated, by the adoption of which the risk of explosion may be greatly, if not entirely, minimized. The most important of these were the complete avoidance of even a trace of oil in any of the fittings, the insertion of a compact porous septum, composed of alternate layers of felt and copper gauze, in the passage to the gauge, so as to prevent any sudden rush of gas, and the reduction as far as possible of all air spaces to which the gas has access. It is thus evident that gauges which have been tested with oil, a usual practice with some makers, should be carefully avoided for use with compressed gases.

A gauge with a patent safety flap, or valve, was shown, being designed to avoid the shock caused by the unavoidable rapidity with which the gases enter the gauge.

ANHYDROUS SULPHATES.

THE anhydrous sulphates of zinc, copper, nickel, and cobalt have been obtained in well developed crystals by M. Klobb, who describes his experiments in the current number of the *Comptes Rendus*. It was first observed that when a small quantity of the ordinary hydrated sulphate of cobalt was allowed to fall into fused sulphate of ammonia it immediately dissolved, imparting a deep blue color to the liquid, and when the heating was continued in such a manner that the ammonium sulphate slowly volatilized away, the walls of the crucible were found to be covered with small red crystals. Upon analysis these crystals proved to be those of anhydrous cobalt sulphate. Similar experiments with the hydrated sulphates of zinc, copper, and nickel succeeded equally well, and it was found to be immaterial whether the hydrated salts with five, six, or seven molecules of water, or the amorphous anhydrous salts obtained by ignition, were employed. The best mode of operating in order to obtain good crystals is briefly as follows: A quantity of ammonium sulphate is placed in an ordinary porcelain crucible; over this is then laid an intimate mixture of ammonium sulphate with one-third its weight of the metallic sulphate required. The crucible, covered by its lid, is then inclosed together with a packing of sand within a Hessian crucible, which is afterward placed in a muffle furnace and heated until the sulphate of ammonia has all escaped. The heating should then be at once discontinued, in order to prevent decomposition of the metallic sulphate. After cooling, if the heating has been carefully conducted, the residual metallic sulphate is found to be crystalline throughout, and to consist largely of single, well formed crystals. The result is particularly good in the case of zinc sulphate. If quantities of about twenty grammes of anhydrous zinc sulphate are employed, colorless octahedrons two and a half millimeters long may be obtained. These crystals only dissolve with extreme slowness in cold water, but are much more rapidly dissolved upon warming. Sulphate of copper treated in a similar manner yields prismatic needles of the anhydrous salt. These crystals present a pale gray appearance, but on being left exposed to the air for a few days they assume first a green tint and subsequently pass over to the ordinary penta-hydrated blue salt. Unlike the crystals of anhydrous zinc sulphate, they are rapidly dissolved by cold water, forming the usual blue solution. The crystals of anhydrous sulphate of cobalt prepared in like manner consist of brilliant red octahedrons, which are apparently unaltered by exposure to the air, and which are only slightly attacked by water even when boiling. Still more remarkable are the green crystals of anhydrous nickel sulphate obtained by the above mode of preparation, for these crystals, so unlike the readily soluble hydrated sulphate, are practically insoluble both in cold and boiling water. This last instance affords a striking example of the influence of water of crystallization upon the solubility of a salt.—*Nature*.

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